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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

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MOTORS.

The term "motor" has been appropriated by the electrical engineers in recent years to designate the electric motor, and it has come to mean—among them, at least—an electric motor, almost as specifically as the term "dynamo" implies a machine employed to generate electric current. But, with the development of the small gasoline and oil engines for propelling automobiles, the term "motor" is being used more and more in its more general sense. Gasoline and oil engines are now frequently referred to as motors, without any distinguishing adjective, just as is the electric motor, so that there is, at times, chance for confusion. This is perhaps a little unfortunate from the standpoint of the electrician, because "motor" is a short, expressive word, and it is inconvenient to be forced always to tack on to it an adjective longer than itself. But it is too late now to make a change by substituting some other word for "motor" when referring to the electrical machine, and when the context does not eliminate all risk of confusion the adjective must be used. Possibly the difficulty will be overcome if the electric motor succeeds in driving all other motors from the field.

THE LOUISIANA PURCHASE EXPOSITION.

Under clear skies, and without a single incident to mar its perfect arrangement, the inauguration ceremony of opening the World's Fair at St. Louis, Mo., was held on April 30, 1904. Although there is a great deal yet to be done to complete the exhibit palaces in their every detail, the exposition as a whole was quite ready for the enthusiastic throng that had gathered during the few days immediately preceding the day of opening. An army of workers had labored diligently, under the direction of many masters of many industries, to weld the products of a universe into a composite world of lesser dimensions, with a result that once more stands for the inevitable domination of man over things, animate and inanimate.

Electricity at the Fair.

Of course, there is much to talk over and marvel at; much for artisans and professional men in every calling to take pride in. Giving every other element its due, however, electricity and the results of electrical phenomena are entitled to a foremost position in the scale of development and application. By day and by night the visitor is confronted with the never-ending possibilities of electrical apparatus, and apparently its scope has neither depth nor breadth for limits as we understand these terms to-day. The visitor will be transported from place to place on an electric railway. He will talk over an electric telephone circuit, or transmit other messages through the medium of the telegraph, with or without wires. Electric fans will cool the atmosphere, and electric lights will dissipate the darkness of nightfall. Cascades and waterfalls will take on a new beauty with the irridescence of many-colored beams glittering through the spray.

Manifold Applications.

It is almost impossible to realize the variety of ways in which electrical phenomena are being applied: in units of every dimension; for measurements of various classes; as the motive power for countless types of mechanisms, and for bringing about different methods of illumination; for water-purification, for nitrification of the atmosphere, and for application in electrotherapeutics. In fact, there will be brought home the realization that this is indeed an electrical age, and that now and apparently forever must the whole world depend largely upon the engineer for its guidance and development.

TAMING THE THUNDERBOLT.

Ever since Franklin's kite was sent upon its famous flight, certain optimistic individuals have thought that this pretty experiment was the key to untold power and wealth. The tumult caused by a severe thunder-storm has evidently led them to believe that vast quantities of electricity are tumbling around in the upper air, and to render these available to man needs but some method of tapping the invisible reservoir. Now, Rowland said that the quantity of electricity taking part in a flash of lightning could be collected on a thimble; but the handling and restraining of this thimbleful of electricity present a problem which few electrical engineers would care to undertake. It is a great achievement to use the water at Niagara to drive a dynamo, but most of us would hesitate at the thought of employing a stream of rifle bullets for the same purpose.

However, some men seem to be more courageous. We are told in a recent despatch from the West, that the electricity running wild above Pike's Peak is to be harnessed to drive trains on the cog road. It is said that Pike's Peak is the "natural grounding spot for millions of volts of electricity that would otherwise be dissipated over a large area." To make this inexhaustible supply available, a complete circuit of wire is to be erected on poles, each having at the top a "lightning rod designed to attract the electricity which plays about the peak so fiercely." The electricity thus collected will be conducted to a power-house and there transformed and stored. It will then be fed out to the cars through a double trolley circuit, the return circuit being necessary to prevent the electricity from "grounding and thus burning out the motors." Unfortunately, the announcement of this great undertaking does not describe the method of transformation and storage, although the plans of the station and specifications which, it is said, are being prepared should be most interesting reading. Another question is, what is to be done with the electricity which is continually drawn into the system? According to the announcement, great precautions are to be taken to prevent it from getting to the ground; but as it continues to accumulate in the storage department, a point must eventually be reached where something will have to "bust."

THE AUTOMOBILE PARADE.

On Saturday, April 30, the Automobile Club of America held an automobile parade in New York city. Not only were pleasure carriages in line, but commercial vehicles of various types were represented. The parade gave opportunity for an excellent display of manœuvering and facility of control. The same number of vehicles with horses attached would have used up three or four times as much space and no doubt become hopelessly entangled. The electric vehicle, than which there is none better for city work, was greatly admired. The ease of control, graceful lines, absence of vibration and freedom from odors or other objectionable features rendered it highly popular.

THE MOTOR DRIVE.

The success of the electric motor when used for driving of many different kinds of machinery is undisputed—in fact, this method of operation is becoming a standard in factories. But believers in the electric motor are far from satisfied with the conquests which it has made, and they are continually urging the adoption of this secondary mover in places where there seems, at first sight, to be no need for it. A recent instance of this is furnished by the so-called motor cars which were set to work a short time ago on certain of the suburban lines of the North-Eastern Railway Company, of England.

An Old System.

These motor cars call to mind earlier attempts to combine the advantages of the electric motor for propelling vehicles with the gas engine's independence of outside sources of power. A notable instance of this is the once-famous Heilmann locomotive, though others sought to apply this combination to street railway service and to automobiles.

The Car Equipment.

In the motor cars adopted by the North-Eastern Railway Company a four-cylinder gasoline engine, rated at eighty horse-power, is directly connected to a fifty-five-kilowatt compound-wound generator, one end of the car being set aside for this machinery. The car has two trucks, that under the end containing the machinery, being equipped with two fifty-five-horse-power railway motors. There is also a storage battery, rated at 120 ampere-hours, placed under the car-body. The method of control is practically identical with the systems used on electric cars, the motors being connected in series for slow running, and in parallel for higher speeds. However, it is possible to vary the voltage of the generator in order to obtain the highest speeds.

Possible Success of the System.

This combination does not present any novel features. It gives the car those features of operation which have made the electric equipment successful; and besides being entirely independent, the storage battery allows the generating equipment to be operated under favorable conditions. In spite of these advantages, the combination has not been successfully applied heretofore. But conditions on steam railroads are different from those obtaining in street railway or tramway service, and failure in one application is not necessarily followed by failure in the other. Criticisms directed against such combinations are usually based upon the complexity of the equipment, its cost and weight. However, if the advantages sought justify the expense, the other disadvantages do not necessarily condemn the system. It may be that, with our greater knowledge, and with the improved machinery of to-day, these cars will prove to be entirely successful. In any event, this new application of an old system will be watched with much interest, and it is not impossible that it may have some influence on the design of motor-propelled vehicles. The question to be answered is: how much sacrifice of simplicity is justified in order to gain the advantages of the electric drive?

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

MUCH ENTHUSIASM SHOWN AS THE TIME FOR CONVENTION DRAWS NEAR.

Within about two weeks the twenty-seventh convention of the National Electric Light Association will be in full swing. The present indications are that this will be a most important and well-attended session. President Charles L. Edgar and his associates have labored faithfully to provide well for the visiting delegates, both in the matter of business and social engagements.

The following programme has been announced for the convention, which will be held in Boston, Mass., May 24, 25, 26, 27:

"The Sale of Electrical Energy"—W. F. White.
"Economy Test of a 5,500-Horse-Power, Three-Cylinder, Compound Engine and Generator"—J. D. Andrew and W. F. Wells.
"A One-Hundred-Mile Transmission Line"—Robert Howes.
"The Mechanical Stoker and the Human Operator"—Edwin Yawger.
"The Organization and Equipment of an Arc Lamp Department"—Samuel G. Rhodes.
"Practical Notes on Steam Turbines"—Francis Hodgkinson.
"Electric Light and Power Plants in Connection with Ice Plants"—C. L. Wakefield.
"Single-Phase Power Motors for Electric Lighting Stations"—W. A. Layman.
"A Three-Wire, 500-Volt Lighting System"—Walter I. Barnes.
"Notes on the Internal-Combustion Engine as Applied to Central Station Service"—E. E. Arnold.
"A Proposed System of Standard Instruments for Operating Companies"—H. P. Davis.
"Remote Control of Electrical Apparatus"—William H. Cole.

In addition to these papers, which are already in print, are three or four others on timely subjects which have not yet gone to press, among them one by Dr. F. A. C. Perrine, on "Types of Large Water-Power Installations."

The reports are as follows:

"Report on Progress"—T. Commerford Martin.
"Report of Committee on District Heating"—E. F. McCabe, chairman.
"Report on Lost and Unaccounted-for Current"—C. W. Humphrey.
"Report on Purchased Electric Power in Factories"—W. H. Atkins, chairman.
"Report on Office Methods and Accounting"—Frank W. Frueauff.
"Report on Advertising"—La Rue Vredenburgh.
"Report on Sign and Decorative Lighting"—Arthur Williams.
"Report on Analysis of Flue Gases"—Henry L. Doherty, chairman.
"Report on Standard Rules for Electrical Construction and Operation"—Captain William Brophy, chairman.
"Report of Committee Appointed to Investigate the Steam Turbine"—William C. L. Eglin, chairman.
"Wrinkle Department"—Edited by Charles H. Williams.
"Question Box"—Edited by H. T. Hartman.

There are 100 or more "wrinkles" submitted, and the Question Box contains nearly 450 questions, nearly every one of which has been answered.

In addition to the papers above enumerated will be the paper on "Underground Construction" for which Past-President Doherty will present a gold medal.

ENTERTAINMENT.

The following named gentlemen comprise the local entertainment committee:

James I. Ayer, chairman, Professor C. A. Adams, Albert Anderson, William H. Atkins, F. E. Barker, F. P. Barnes, R. N. C. Barnes, George H. Berg, H. Bottomley, Captain William Brophy, F. E. Cabot, C. W. Cartwright, A. E. Childs, A. T. Clark, Professor Henry E. Clifford, D. P. Robinson, Charles B. Davis, George C. Ewing, H. H. Fairbanks, H. C. Farnsworth, George H. Finn, Almon Foster, W. C. Fish, Charles J. Hatch, Percy Hodges, W. E. Holmes, G. W. Holtzer, Sidney Hosmer, P. J. Kennedy, A. H. Kimball, George B. Lauder, F. W. Lord, Emil O. Lundin, Norman Marshall, E. H. Mather, Everett Morss, H. W. Moses, W. L. Mulligan, J. H. Parker, H. S. Potter, C. B. Price, C. F. Pritchard, Andrew Raeburn, F. H. Raymond, F. S. Richardson, S. B. Condit, Jr., Frank Ridlon, F. P. Royce, G. L. Sadler, F. S. V. Sias, F. E. Smith, Professor H. B. Smith, J. A. Smith, J. Brodie Smith, George R. Stetson, F. J. Stone, G. M. Stuart, La Rue Vredenburgh, Thomas C. Wales, R. L. Warner, N. T. Wilcox, S. B. Wetherbee, F. S. Wilson, W. C. Woodward.

The following programme will be carried out for the entertainment of the visitors:

On Tuesday afternoon the ladies in attendance will take carriages and drive through the Fenway and possibly to some points of interest about Boston. Committee—Charles J. Hatch, W. E. Holmes, D. P. Robinson.

On Tuesday evening there will be given at Hotel Vendome a lecture on "Historical and Electrical Boston," under the charge of La Rue Vredenburgh.

On Wednesday morning the ladies will visit the shopping district. Committee—H. S. Potter, F. S. Wilson, F. S. V. Sias.

On Wednesday afternoon there will be a trip down the harbor, and on return a visit to the L street station of the Boston Edison Company. Committee—Sidney Hosmer, Percy Hodges, W. C. Woodward, Professor H. E. Clifford.

Wednesday evening will be spent at Symphony Hall, attending a popular concert. All the space within the rail has been reserved for the use of the guests and their friends. Committee—R. L. Warner, Thomas C. Wales, R. N. C. Barnes, George C. Ewing, F. W. Lord.

On Thursday there will be provided for the ladies a trip in automobiles to Wayside Inn, Lexington and Concord. Committee—C. B. Davis, George H. Berg, F. S. Wilson.

On Friday the entire day will be devoted to personally conducted trips in and about Boston. The business sessions of the association will close on Thursday evening, leaving Friday to be devoted purely to entertainment in the manner above outlined.

A general information bureau will be established at the Hotel Vendome, in charge of Messrs. Vose and Peasley, and in addition to the usual duties that such a bureau is called upon to perform, it is intended to have during the week lists made of those desiring to take any particular trips or see any particular points on Friday, so that adequate arrangements may be made for properly personally conducting the visitors to such places as they desire to go.

Mr. W. H. Atkins will have general charge of the entertainment on Friday, and the following committees have been selected to arrange details for the excursions as listed: Institute of Technology, Professor H. E. Clifford; Harvard University, Professor C. A. Adams; Bunker Hill Monument and Navy Yard, P. J. Kennedy; Fore River Ship and Engine Company, Charles H. Parker; Simplex Electric Company, Everett Morss; Holtzer-Cabot Electric Company, C. W. Holtzer; power stations, Boston, I. E. Moultrop; trolley trips, Paul Winsor; N. E. Gas and Coke Company, George H. Finn.

Radioactivity for Determining the Capacity of Condensers.

Mr. J. A. McClelland, in the *Philosophical Magazine* for April, describes an application of the ionization current obtained by the use of a radioactive substance, such as uranium, for the determination of capacities down to a few microfarads. The radioactive substance must give a constant ionization current, and this is used to charge one condenser to a given potential, and then another, the time taken in the two cases being observed. The ratio of the two capacities is given by the ratio of the time intervals required to charge them. The method does not require a supply of radium, as uranium is to be found in every laboratory and gives better results. A few grammes of a uranium salt were spread on a sheet of paper placed on an insulated metal plate, surmounted by another insulated plate connected to a battery. As soon as the difference of potential between the two plates has attained the maximum, the current becomes constant. The method gives very accurate results, and may be used for measuring capacities varying from one microfarad to one micro-microfarad. It is very free from errors, and the only quantity to be measured is the time interval.

The Faraday Society.

An ordinary meeting of the Faraday Society was held on Wednesday, April 13, at the Institution of Electrical Engineers, London, England, Mr. J. Swinburne, vice-president, was in the chair.

Mr. Arthur J. Hiorns read an abstract of his paper on "Alloys of Copper and Arsenic," illustrating his remarks by a series of lantern slides. The object of the author's investigations was to ascertain the exact relation between copper and arsenic in binary alloys, and the limit of proportion of arsenic that can be retained in copper in the cold solid state.

The addition of arsenic lowers the melting point of copper uniformly down to about fourteen per cent, when a steep fall in the freezing-point curve occurs, reaching its lowest point at 685 degrees centigrade. This alloy contains 19.2 per cent of arsenic, which corresponds to the formula Cu_4As_3. The alloy with twenty-two per cent of arsenic freezes at 708 degrees, and the temperature gradually rises until the alloy with 28.34 is reached at 747 degrees. This is the compound Cu_3As. At 810 degrees another chemical compound freezes, having the chemical formula Cu_5As_2; it contains 32.2 per cent of arsenic. Beyond this point the temperature gradually falls again to a minimum at the alloy with about thirty-five per cent of arsenic. The curve then rises to another summit at 740 degrees, forming the compound Cu_2As, with 37.24 per cent of arsenic. From this position the curve descends to 702 degrees with the alloy containing forty-one per cent of arsenic; this is nearly the practical limit of the direct combination of copper and arsenic.

The top surfaces of many of the alloys were photographed. The types of pattern visible on the etched surface depend upon the position of the freezing point on the curve. For alloys whose freezing point is on or near the summit of a curve, the whole of the section is composed of one substance, generally made up of crystal grains having fine boundaries. When by addition of copper or arsenic a summit of a curve is left, the lines between the crystal grains widen and become filled with a network of matter differing from that of the crystals and generally showing a more or less striated appearance, so characteristic of eutectics. As the bottom of a curve leading from a summit is reached the eutectic occupies the whole surface. It is noticeable that the alloy of minimum fusion of copper-arsenic alloys has an extremely fine striated structure. Any deviation in composition from the eutectic proportion causes the breaking up of this striated pattern, and grains of one of the constituents appear in the eutectic matrix.

A microscopic examination was also made of polished sections of the various alloys. These when viewed in daylight are all copper-colored in those with little arsenic, and gradually get paler as the arsenic is increased. When the alloy with 19.2 per cent is reached, the surface appears of a pale blue color, and this is continued up to the compound Cu_4As_3, containing 28.34 per cent, which is of a deeper blue color. The alloys between 19.2 and 28.3 per cent have a paler blue tint because the blue constituent is associated with a constituent richer in copper, forming a eutectic mixture. The alloy with thirty per cent is of a light purple color, and when the compound Cu_5As_2 is reached, containing 32.2 per cent, a full reddish purple is obtained. This purple color maintains up to the limit of these experiments with forty-five per cent of arsenic, but gets gradually paler.

The paper concludes with a detailed description of the various alloys, fully illustrated by excellent photomicrographs.

Mr. Swinburne, referring to the melting point of arsenics, which the author thought could only be obtained by experiments made under great pressure, observed that the effect of pressure on the melting point of solids is very small, and that probably at ordinary pressures the melting point of arsenic was very close to its volatilizing point.

Dr. Pekin hoped that the author would supplement his researches by making conductivity measurements of the series of alloys.

Dr. C. H. Desch made some interesting comparisons between the results obtained by the author and those published by other investigators in the case of the analogous series of copper-antimony alloys.

Mr. E. G. P. Bousfield contributed a paper on "Experiments with a New Primary Cell." The cell consists of an inner porous pot containing nitric acid and a carbon pole, and an outer vessel containing sodium hydrate solution and a metal pole, preferably zinc; *i. e.*, a solution of from twelve per cent to fifteen per cent, using solutions of maximum conductivity with zinc and carbon poles on open circuit, an electromotive force of 2.6 volts may be obtained. Not only does the cell possess this comparatively high electromotive force, but it may be short-circuited far longer than most cells before it runs down. A cell short-circuited through a total resistance of 0.61 ohm gave a current of 4.18 amperes which fell to 2.61 in an hour, 2.38 in two and one-quarter hours, and 1.75 in six hours. A smaller cell gave a fairly constant current of about 0.8 ampere for twenty or twenty-five hours. Discharge curves are given in the paper.

Acids other than nitrate were experimented with. Some of them gave higher electromotive forces than nitric acid, but no other acid possessed the same "lasting powers." The effect of using various metals instead of zinc was also tried; some of these gave higher electromotive forces than the zinc, but the high readings were quite transitory. Using two carbon poles the electromotive force was about 1.35 volts. The cell is then similar to Becquerel's platinum cell, in which the plates are immersed in acid and caustic potash respectively.

Mr. W. R. Cooper referred to the disadvantages of both nitric acid and caustic soda as electrolytes. The high electromotive force of the cell was only apparent, because it rapidly fell to a working value of 1.8 or 1.9. He would like to have seen comparative tests made, say, with a bichromate cell.

Mr. J. Swinburne mentioned a suggestion made by Dr. Swan, that the cell would be improved if it were converted into a three-fluid cell, with a neutral electrolyte, *e. g.*, $NaNO_3$, in the mid-compartment.

Mr. Bousfield also contributed a "Note on Determining Accurately the Percentage of Ozone in Gases Not Dissociated by Moderate Heat." Difficulty was found in determining accurately the quantities of ozone formed in different electrolytic reactions. The potassium iodide test is sufficiently accurate for most purposes, but for very accurate work it is not satisfactory, as an error of five per cent or more is often obtained with a slightly alkaline solution, and an error of as much as one or two per cent with an acid solution. Estimating the ozone by weight, using glass globes for that purpose, was also found to be somewhat uncertain, due to the condensation of moisture on the glass. The method recommended by the author is a measurement by volume. A certain quantity of gas containing ozone is measured. This gas is then passed over some substance, such as heated platinized asbestos, which is capable of converting ozone into ordinary oxygen. On again measuring the gases, an increase of value due to the breaking down of O_3 molecules into O_2 molecules is found. From this increase of volume the quantity and percentage of ozone originally present is readily calculated. A description of the simple apparatus required for the measurements is given in the paper.

COMMON BATTERY TELEPHONE SYSTEMS—IV.

BY J. C. KELSEY.

THE REPEATING COIL SYSTEM.

The expressions common battery, central energy and central battery have identical meaning. They represent the practice in which the subscriber directs the actions of the operator by the movement of the hook which supports the receiver. Removing the receiver allows the hook to rise, and causes a line signal to be given at the central office for connection. Hanging up receiver lowers the hook and causes a cord signal to be given for disconnection. If a second connection is desired, the alternate raising and lowering of the hook alternates the cord signal, and notifies the operator of the subscriber's desire. The local battery system has no such advantage.

Common battery systems may be classified in two divisions. First, those using the repeating coil in the cord circuit, and second, those using retardation coils and condensers, either directly or indirectly with the cord circuit. The repeating coil system is the older, and naturally grew out of conditions of previous local battery practice. The retardation and condenser principle is a newer condition, and is necessarily the outgrowth of the cautious patent protection of the prior system. Its usage is characteristic of the independent interests, although the licensee companies are using the retardation principle in the smaller cities, where the capacity does not exceed two thousand lines. The comparative advantages of the two systems are equivalent.

The first widely used repeating coil system for large city practice was not common battery in its strictest sense. There were three distinct batteries, having a respective pressure of twenty, eight and four volts. The twenty-volt battery supplied current for talking and for the operation of the line and cord relays. The eight-volt battery supplied current to the cord or supervisory lamps, the pilot lamps, and operated the cut-off relays. This battery carried the heaviest load, and was composed of twenty-five G-11 elements of chloride make, with a capacity of 2,000 ampere-hours. The four-volt battery supplied current to the line lamps, and each cell of the battery supplied alternate operators' transmitters with current. On account of the low voltage of the lamps, the respective cells of the four and eight-volt batteries could not be charged to their limit of 2.6 volts, because no incandescent lamp can stand a strain of nearly thirty per cent over-voltage. Therefore, the four and eight-volt batteries were duplicated, so that one set could be charged, while the other was discharging. This added to the first cost of the plant, and increased the maintenance cost also. These multi-voltage systems are giving excellent service to the cities of St. Louis, Indianapolis, Minneapolis, Cleveland, New Orleans, and others; St. Louis being said to have the most satisfactory service in the world.

The act of replacing an antiquated system with a newer one, local and common battery, for instance, makes it imperative that the operating company shall look forward to that time when the new system shall begin operation without interfering with the daily service of its thousands of subscribers. To accomplish this purpose the instrument must be arranged so that it will operate on both systems, and the subscriber be unaware of the change, or cut-over, which usually occurs at noon or night. He probably might not be aware of the change until a company inspector removed the handle from the generator of his instrument. This condition is attained by a condenser. In Fig. 6 the bridging telephone is shown at the left, with a condenser K placed in the ringer circuit. As the generator is normally open, no change is necessary. With the condenser in the ringer circuit, the instrument circuit is open to continuous currents, and thereby operative to common battery. It is closed to alternating currents, and is operative to both common and local battery operators for ringing. Removing the receiver from the hook closes the circuit through the receiver and an induction coil secondary. Hanging up receiver, the circuit is opened. That fulfils common battery requirements. The condenser does not interfere with local battery requirements. After sufficient time the company removes the old instrument and replaces it with a common battery instrument, which is shown at right of the figure, in which T is trans-

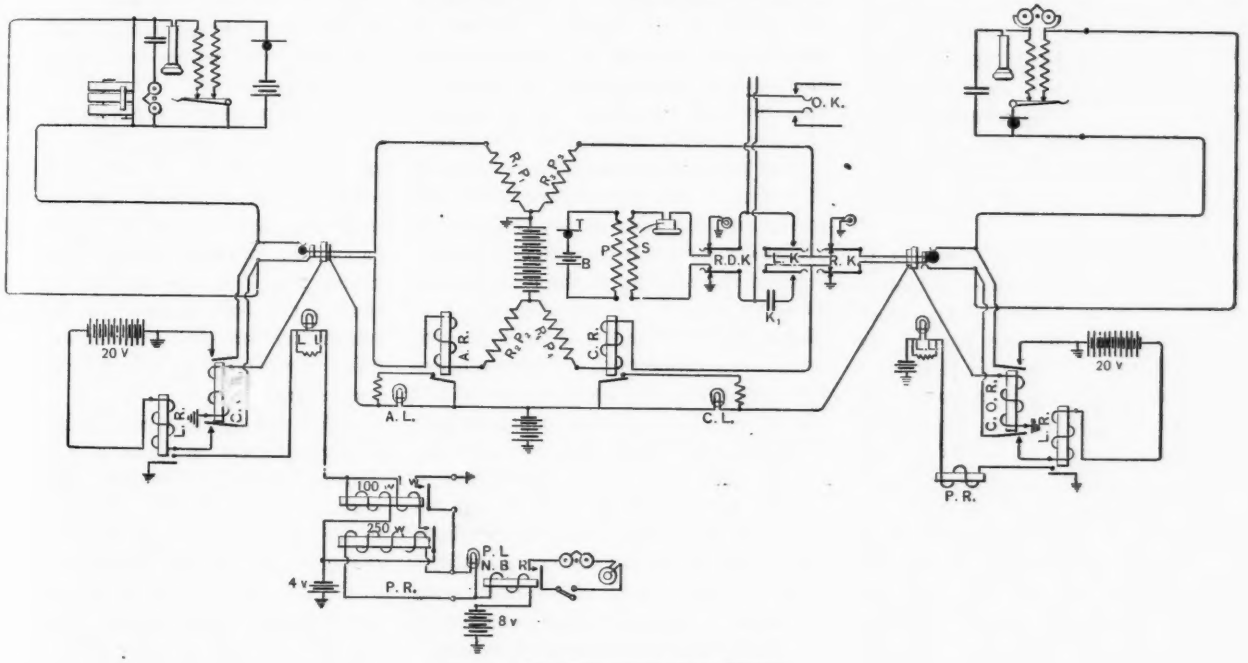


FIG. 6.—THE REPEATING COIL SYSTEM.

mitter, R the receiver, K the condenser, B the ringers, S the secondary and P the primary. The removal of the hook places the transmitter and induction coil secondary across the line in series.

To call the operator the removal of the receiver causes battery current to flow from the twenty-volt battery, through the windings of an eighty-ohm relay LR, over the line to the transmitter and induction coil secondary, and thence back to battery over the other side of the line. The contacts of line relay LR close the four-volt battery through the line lamp LL placed above the answering jack of the line in full view of the operator who, seeing the lighted lamp, inserts a plug to answer.

In local battery practice to prevent a drop falling unseen contacts were arranged whereby the falling of a shutter would set into motion a night bell. In common battery practice lamps are likely to burn out, or owing to low voltage the corrosion of the contacts prevents lighting. In a system of 5,000 lines, with 5,000 lamps, this trouble would be very serious, were it not for a very ingenious solution of the difficulty.

Each operator handles 100 lines as an average. Associated with these 100 lamps is one lamp called a pilot lamp, which lights each time that any one of the smaller 100 lamps does. This pilot lamp PL is controlled by a pilot relay PR, through whose windings the entire bank of 100 lamps receives its battery current during a call. When a call is made the line relay LR closes the lamp circuit through the four-volt battery and the pilot relay. If the lamp is dead, or contacts corroded, no current will flow, and the pilot relay will not be energized, and the pilot lamp will not light also. But the pilot lamp must light, whether or not the line lamp does. The operator must have some indication. To compel the pilot lamp to light, a shunt is placed about the contact springs of each lamp socket. This shunt is of 100 ohms resistance, and does not impair brightness of the lamp. If the lamp is out of order, enough current will flow through that shunt to energize the pilot relay, light the pilot lamp and notify the operator of a call somewhere in the 100 bank. She would therefore plug in, and hunt through all the answering jacks until she found the party. After giving the party the desired connection, she would report the trouble.

The pilot relay PR is of peculiar construction. It has two cores, two armatures and three windings. The 100 and the one-ohm windings are on same core and wound in same direction. When the line relay LR closes contacts the current would pass from the four-volt battery through contact *a*, 100-ohm winding, contact *b*, through lamp shunt of LL, thence to ground. Then the energized core of 100-ohm winding would attract its armature, and close a circuit from the eight-volt battery to contact *e*, pilot lamp LP, contact *d*, contact *c*, thence to ground, lighting the pilot lamp regardless of presence of lamp LL.

If the lamp LL is in order, it will not be lighted until after the pilot lamp. In parallel with pilot lamp LP is a 240-ohm winding about the core of the other relay, high enough in resistance to prevent dimming of the pilot lamp. When the current passes through LP some of the current passes through the 240-ohm winding, thereby energizing it. Its contacts close the circuit of the one-ohm winding in parallel with the 100-ohm winding, which allows LL to light by reason of its twenty-ohm filament receiving current through one ohm in series rather than 100 ohms.

The line ends in a multiple of jacks at the office, one side ending at the tip spring and the other at the ring spring. The sleeve contact is connected to ground through the winding of the cut-off relay. The function of this cut-off relay is to disassociate the line signal from the line when upon connection. It also removes the battery from the line circuits, because it was found advantageous to supply battery from the cord circuit during connection. Cut-off relay COR has a resistance of twenty ohms, and is actuated by the entrance of the plug, upon whose sleeve there exists eight-volt battery potential.

As the battery is cut off the line during a connection, the cord circuit must restore it. It is the cutting off of the battery that gives the subscriber the vicious click in his receiver. To give quiet connection between metallic lines and grounded lines, a repeating coil is necessary. Its inductive windings prevent cross-talk between the cord circuits. It individualizes each cord circuit and two talking subscribers. The two tips of the plugs are connected to grounded side of battery, and two rings connected to negative side. An impulse coming in from the tip of the plug would pass through R1P1, battery R2P2, thence to ring of the plug. It would induce an impulse in R3P3, battery R4P4, out through tip and ring at the right.

The act of plugging-in cuts off the battery and line signal. At the same instant the four-volt lamp AL lights, being in series with COR. The battery flows to the subscriber through the cord circuit, in which a relay AR is placed. This relay is non-inductive, because the voice currents have to pass through it. Its eleven ohms copper winding is paralleled by a 100-ohm German silver winding, which does not weaken the relay to a great extent. The relay slightly unbalances the line where there is great inductive disturbance. The subscriber, with his telephone off the hook, closes the circuit through relay AR, whose contacts close a ten-ohm shunt about the lamp AL, which with the aid of an opalescent shade has the appearance of extinguishment, and indicating to the operator the attitude of the subscriber.

To talk to the subscriber the operator throws the key LK which puts her talking set across the circuit on the calling side. In her talking set, in the receiver and secondary circuit, is placed a condenser to prevent the savage receiver click, which the twenty-volt battery would cause when she throws the key. The condenser K1 also prevents interference with the calling cord relay and signal. While it would cause no particular trouble, the action would be useless anyway. The transmitter is of local battery type, in which B is a half of the four-volt battery, T the transmitter, and P the primary of the induction coil. This method of energizing transmitters was conductive to some cross-talk, particularly if the operators had loud, sharp voices.

Before the operator could call a party, she would have to make a test in the multiple to see if the line desired was available. Touching the tip of the plug to the sleeve of the jack would cause no test click, because the ground on the tip of the plug would meet the ground at the sleeve, made through the cut-off relay. If the jack was not busy, she would plug in and throw the key RK for an instant, which would put alternating current on the calling plug, thence to the line, and through the subscriber's instrument, more particularly the condenser, and 1,000-ohm ringers.

The act of inserting the calling plug would cause the eight-volt battery to flow through the calling supervisory lamp CL, thence through the cut-off relay to ground, lighting the lamp and operating the cut-off relay. If the cut-off relay had not been operated, the ringing current would have a shorter path through the line relay and battery, thence to ground. It would weaken the ringing and agitate the line relay, thereby flashing the line lamp LL.

When the called party answers, the current flows out over the line and instrument, through the cord relay CR, causing it to be energized. It pulls up its contacts

about the ten-ohm shunt and lamp, and it appears to go out, thereby indicating to the operator that there is no further need of ringing.

Both lamps are out, as both parties are talking. Both cut-off relays are open, and the parties are in inductive relation through the windings of the repeating coil. Just what value the electromotive force of the induced alternating current has is yet to be determined. It is very low, anyway.

When the parties hang up their receivers, the current can no longer flow through the subscriber's instrument, nor through the cord relays AR and CR, and their contacts fall back. This removes the shunts from the lamps and they come up to their full brightness. The operator then pulls down the connection without the challenge necessary in local battery practice.

If the *a* call is made for a busy line, the operator will know it by receiving a succession of clicks in her receiver, that is, a click for each time she withdraws the tip of the plug from the sleeve of the jack. A busy jack has just the reverse potential of the normal jack. It gets battery potential from the entrance of another operator's plug, somewhere along the multiple. When the testing operator touches the tip to the sleeve, the battery that exists on the sleeve tends to flow to ground through the quarter of the repeating coil R3P3. In so doing it stores magnetic energy in the core of the repeating coil. The operator does hear a slight click at this time, but not enough to decide her. It takes an element of time for a current to be established in a circuit containing impedance. This condition obtains in the quarter of the coil R3P3. About the time the operator withdraws the tip of the plug the current has arisen to its full value, and the core may be said to be fully charged with lines of force. Breaking the circuit causes this magnetic energy to dissipate, which it does most rapidly, cutting the conductors of the repeating coil in the quickest time possible, hence the production of an electromotive force in the coils of the repeating coil, which shows itself in the form of a click in the operator's receiver, because she is bridged across the calling side of the coil, and also in the waiting subscriber's ear, because he is bridged across the other side of the coil. Testing can be accomplished by either plug, as is the case with few common battery systems.

This system has the disadvantage of not being able to use a pilot lamp for the answering cords. Only those systems which open the lamp circuit to extinguish it find it available. It has the advantage of connecting grounded and metallic lines, however, that retardation systems lack.

All the eight-volt battery current for the pilot lamps passes through a night bell relay NBR, which closes contacts about a ringing generator and bell. A switch, mounted upon the board, serves to short-circuit this relay during the day.

ELECTROLYTIC IRON.[1]

BY C. F. BURGESS AND CARL HAMBUECHEN.

A great deal of attention has been devoted of late to the application of electrical energy to the metallurgy of iron and some of the results attained seem to point to developments of industrial importance. Most of the attempts to apply electrical energy have been through its transformation into heat for use in various smelting and reduction processes. That the electrolytic as well as the electrothermal effect might be utilized industrially does not seem to have been considered seriously, as it has been commonly held that the difficulties inherent in the deposition of iron are such as to preclude its playing an important part in the industrial electrometallurgy of this element.

It has, however, been shown, as a result of recent experimental work carried on in the laboratory of applied electrochemistry of the University of Wisconsin, that electrolytic iron can be produced in such quantities and at such cost as to make it a material of commercial as well as of scientific importance, should sufficient demand for it arise.

A survey of available literature on the subject of electrolytic iron leads naturally to the assumption that its deposition is difficult to accomplish and that there are few solutions from which it can be deposited. Moreover, it has been held that a satisfactory quality of deposit can be attained only by the use of very low current densities and an exceedingly slow rate of deposition. Practically, the only uses to which electrolytic iron has been put are in the so-called "steel facing" of dies and electrotypes and as a material for investigating the properties of the pure metal.

The hardness of electrolytic iron, which makes it especially suited to the facing of electrotypes, is due to the occluded hydrogen, which is practically the only impurity present. In fact the very term "electrolytic iron" is commonly assumed to be synonymous with "pure iron." In just what manner the hydrogen is held by the metal is a matter of doubt, it being claimed by some that it is simply condensed and by others that it forms a definite hydride. Such iron may contain this gas in quantities equal to several hundred times the volume of the metal, and it can be almost entirely freed from it by heating. Certain investigators have found that electrolytic iron contains carbon in appreciable quantities, while others have found that carbon is absent.

Dr. John A. Mathews, "Alloy Steels, Mineral Industry for 1902," states that "pure iron may properly be classed among the 'rare metals'; thousands of tons of iron alloyed with impurities from a fraction of one per cent upward are produced annually, but not a pound of iron in its pure elemental condition has ever been made under ordinary smelting conditions. By 'pure' we mean in a condition comparable with that in which the precious metals are produced or as pure as the best electrolytic copper and nickel. . . . Just as pure iron is a chemical curiosity, so also is an alloy containing only iron and carbon. In practice, at least, four other solid elements occur fortuitously in all steels, *viz.*, manganese, silicon, sulphur and phosphorous."

Something over two years ago the authors of this paper undertook an experimental investigation of the conditions suitable for electrolytically depositing iron, and this work has proceeded almost without interruption since that time. The primary object of the investigation was to produce, if possible, pure iron in such quantities and at such cost as to make it an available material for further enquiry into its properties. Since our attention has been confined almost exclusively to this phase of the problem, the observations which have been made as to the physical and chemical properties of the product are by no means exhaustive and, indeed, are considered only as preliminary to a more extensive research which it is hoped to take up in the future.

The preliminary work consisted in testing the various electrolyte materials which had been suggested previously and from these the most promising were selected as the basis for further trials. It is needless to record here the many hundreds of tests which were made, for most of them were unsuccessful, nor is it necessary to recite the difficulties encountered. The investigation was necessarily a slow one, since many of the trials required days and even weeks of operation before conclusions could be drawn as to their success. A large number of iron salts were used, and the effects of variations of density of solutions, current densities, temperature, agitation of electrolyte and various other factors were noted. As a result of such observation ferrous sulphate with a certain percentage of ammonium sulphate was chosen as affording the most satisfactory results, and the process, as it is now being operated on a small experimental scale, may be briefly described as follows:

[1] Paper read at the meeting of the American Electrochemical Society, Washington, April 9.

the electrolyte consists of ferrous and ammonium sulphates; the current density at the cathode is six to ten amperes per square foot of cathode surface and at the anode slightly less; the electromotive force for each cell is slightly under one volt; the temperature of electrolyte is about thirty degrees centigrade; the anodes consist of ordinary grades of wrought iron and steel; the starting sheets for the cathodes are of thin sheet iron, previously cleaned of rust and steel.

One of the most serious difficulties encountered was in obtaining a thick deposit of iron. While it was proved that there is a considerable range of conditions under which iron can be deposited uniformly and densely for a few hours, or perhaps for a few days, it was almost always found that the surface would become so rough or pitted, or that such a rapid treeing would take place, or that the deposit would curl up to such a degree, that it was necessary to discontinue the experiment and start a new one under different conditions. But improvements have been gradually effected until at the present time it is possible to continue the run four weeks without replacing the cathodes. At the end of such time the cathode reaches an average thickness of about three-quarters of an inch and the surface is so rough and nodular that it is not considered advisable to carry the deposition further.

The current efficiency of deposition is very closely 100 per cent; that is, there is a deposition of about one gramme per ampere-hour. The electromotive force being one volt gives about 2.2 pounds of iron per kilowatt-hour. Since all the factors which go to make up the cost of large scale production can not be accurately determined from a small scale experiment, it is impossible to state from our investigations what would be the cost of working on an industrial scale. For the past six months three tanks have been maintained in almost continuous operation, these tanks having the dimensions eight inches wide by thirteen inches long by fifteen inches deep and containing two anodes and one cathode. The finished cathodes from these tanks weigh about twenty pounds, and constitute, perhaps, the largest pieces of electrolytic iron which have, up to the present time, been produced. The total amount of the material which has been produced from all of our experiments is about one-half ton.

A run of two months' duration was made to determine the extent of the deterioration of the electrolyte, resulting in the conclusion that the solution can be kept in good working condition with little trouble or expense. It would appear, therefore, that the cost of refining, aside from fixed charges on plant, and with power at $30 per kilowatt-year, would be under one-half cent per pound of iron, thus placing it not greatly in excess of the cost of refining copper.

Even with these figures realized, whether or not electrolytic iron can be profitably produced depends upon the uses which can be made of the refined metal. These in turn depend upon its properties, the most striking of which is its purity. Although our work was directed toward the production of electrolytic iron in a dense and massive condition rather than in a high degree of purity, analyses which have been made show the purity to be in excess of 99.9 per cent. Not a trace of carbon was detected, and silicon, manganese and other impurities commonly found in iron appear to be absent. The only impurity which has been detected is hydrogen, which is present in appreciable quantities in the metal as taken from the electrolytic tanks. This gaseous element in its physical or chemical combination with iron influences, in a most striking manner, the physical properties of the metal. The hydrogen can be driven off almost completely, if not entirely, by heating to a white heat, the evolution commencing at a temperature below 100 degrees centigrade and becoming rapid at a temperature below a red heat. Electrolytic iron heated in a Thomson welder, or even in a Bunsen burner, has been observed to give off hydrogen so rapidly that it ignites and continues to burn after removing the source of heat, presenting an appearance similar to that which would be produced by dipping the iron in alcohol and igniting it. The metal containing the hydrogen is so hard that it can be filed or sawed only with difficulty, and is so brittle that it is readily shattered by a sharp blow from a hammer. After the expulsion of the gas it becomes softer, and after having been raised to a welding temperature it assumes properties of malleability and toughness similar to those of Swedish iron.

The iron when heated in a forge fire can be readily welded and forged into any desired shape, and various test samples were made in this way. During such working, however, impurities are introduced, analysis invariably showing the presence of a very small percentage of carbon. The cathodes, three-fourths of an inch in thickness, have a surface so rough that they can not be rolled satisfactorily into sheets, though it is possible that improvements can yet be made in this respect which will enable smooth surfaces to be obtained. The deposit adheres so loosely to the starting sheets that it can be removed readily.

A considerable amount of work has been expended in the attempt to melt electrolytic iron without at the same time introducing impurities. The difficulties that lie in the way of doing this, however, are great on account of the high temperatures necessary, and the affinity which the iron at such temperature has for many of the elements. The melting temperature of the pure iron seems to lie closely to that of platinum, though actual values have not as yet been determined from lack of suitable measuring instruments. Various forms of electric furnaces have been constructed for this purpose, a furnace of the inductor type appearing to be the most suitable for preventing the introduction of carbon. Results which have been somewhat satisfactory have been obtained by heating a molten electrolyte between graphite electrodes to a suitable temperature and introducing the metal into such molten bath. The metal thus produced is tough and malleable, while it also has a fracture of coarse crystalline nature. The affinity which the iron has for carbon is shown by the fact that it can be readily melted in a graphite crucible, while a silica crucible heated to a considerably higher degree melts before the iron in it begins to flow. The absorption of the carbon in the former case produces a fusible alloy of iron.

Experiments have shown that the hysteresis, permeability and electrolytic resistance of electrolytic iron are greatly influenced by the amount of hydrogen in it. An iron ring was deposited in such form that a hysteresis and permeability loop could be determined by the Ewing method. It was found that by heating in boiling water the hysteresis was lowered several hundred per cent. By further heating in an oil bath to 200 degrees the value was decreased still further, but to a smaller extent than in the first heating, and upon attempting to heat it to 500 degrees the ring broke and the experiment was therefore interrupted. Certain samples of forged iron have shown permeability values equaling or even exceeding those of the highest permeability standard samples of Swedish iron. Other samples, prepared under apparently identical conditions, showed much poorer results, so that it is impossible as yet to

draw definite conclusions as to the magnetic properties of electrolytic iron.

It having been shown that it is possible for electrolytic iron to be produced at a small cost, the question naturally arises as to what uses there may be for it. The first suggestion which naturally presents itself is that on account of its purity it would serve as a basis for investigating the properties of iron and its alloys. Investigations having for their object the determination of the influence of various elements alloyed with iron as regards its electrical properties, have been unsatisfactory on account of the presence of other impurities which modify or mask the effect of the element which it is desired to study. Starting with the pure iron, therefore, alloys of a predetermined and definite composition can be produced, thus making such investigations of greater simplicity. Unless the difficulties encountered in the working of electrolytic iron on account of its roughness offer too serious an objection, it should compete favorably with the purer grades of commercial iron which are used for various purposes and which sell for three cents and upward per pound.

Electrolytic iron naturally offers the means of manufacturing chemically pure iron compounds and for standardizing solutions in the analytical chemical laboratory. The electrolytic iron, in addition to its purity, has an advantage for the purpose just mentioned of rapidly dissolving in an acid solution. A test which was made to determine the rate at which electrolytic iron and iron wire sold as chemically pure for standardizing purposes dissolve, showed a ratio of one to twelve in favor of the former. By reason of the brittleness imparted by the occluded hydrogen, it can be readily broken up into grains of a desired size and even reduced to a fine powder.

Although the investigations referred to in this paper have covered a considerable length of time, the work which has been done should, perhaps, be considered only as preliminary to a more extended investigation which it is hoped may be taken up in the future. Summing up the work thus far done, it shows that it is possible to obtain electrolytic iron in large quantities and at a reasonable cost, and that, therefore, iron should be added to the list of metals to which the process of electrolytic refining can be applied satisfactorily. It has been demonstrated, also, that such iron possesses a high degree of purity, though just how closely it approaches absolute purity can be shown only by spectroscopic analysis or by other methods which are more accurate than those which have been available.

A CONTRIBUTION TO THE THEORY OF THE REGULATION OF ALTERNATORS.[1]

BY H. M. HOBART AND F. PUNGA.

(Concluded.)

It has been demonstrated[2] that the number of lines per ampere-turn per centimetre of free length may be taken at from 0.4 to 0.8. As a rough approximation we may estimate them as follows:

0.8 line for 1 slot per pole and per phase.
0.7 " " 2 " " " " " "
0.6 " " 3 " " " " " "

Thus in the case under consideration we obtain: $55 \times 1 + 1 + 106 \times 0.7 = 55 + 74 = 129$ lines per ampere-turn.[3]

The inductance per spool of twenty-eight turns is

$$28^2 \times 129 \times 10^{-8} = 0.00100 \text{ henry}$$

and the reactance is

$$2\pi \times 25 \times 0.00100 = 0.157 \text{ ohm.}$$

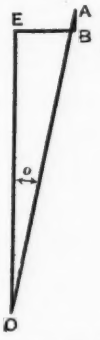


FIG. 9.—REGULATION OF ALTERNATORS.

As there are sixteen such twenty-eight-turn spools per phase, the reactance per phase is

$$16 \times 0.157 = 2.51 \text{ ohms.}$$

The reactance pressure with full-load current of 98.5 amperes is

$$98.5 \times 2.51 = 248 \text{ volts.}$$

From the saturation curve of Fig. 8, we find that 500 ampere-turns per field-spool are necessary for this voltage.

The demagnetizing ampere-turns equal (see table III)

$$3 \times 0.77 \times 0.96 \times 1{,}380 = 3{,}050.$$

Hence, one requires

$$3{,}050 + 500 = 3{,}550$$

field ampere-turns per pole to generate full-load current in the short-circuited windings. The observed value was 3,625 ampere-turns.

This agreement, within two per cent, is, of course, better than can be relied upon, or indeed than is at all necessary; but by this method it appears that an accuracy of from five to ten per cent is generally attainable, in predetermining the excitation corresponding to a given short-circuit current.

We have checked the experimentally observed short-circuit current on eighteen different machines and in eighty-nine per

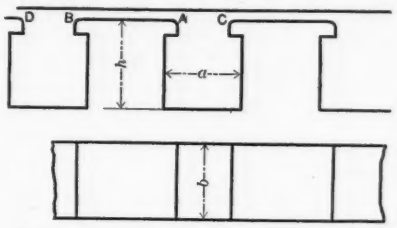


FIG. 10.—REGULATION OF ALTERNATORS.

cent of all cases the agreement was within seven per cent. These are given in table IV, which shows the agreement between calculation and experiment for seven single-phase and eleven three-phase machines, these being the only machines to which the calculation has been applied.

An interesting point to be noticed in the short-circuit current relates to the very small value of the reactance-pressure as compared with that generally ascribed to such proportions. This arises from the elimination of all fluxes emerging from the armature, the remaining flux being, in our opinion, the only one correctly to be considered as pertaining to the reactance-pressure. Now, we should readily admit that with the data at present accessible, the determination of the inductance can only be very rough. But as it exerts so slight an influence upon the result, this inaccuracy in its predetermination is of less importance. In fact, it was the experimental observation that in a great number of machines examined, the short-circuit current deviated but slightly from that corresponding to a magnetomotive force equal to that of the field-spools, that led one of us in a series of articles in which he collaborated[1] to neg-

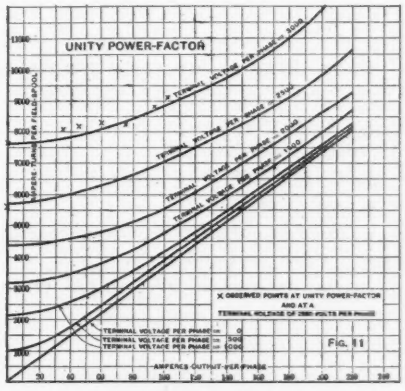


FIG. 11.—REGULATION OF ALTERNATORS.

[1] A paper presented at the 186th meeting of the American Institute of Electrical Engineers, New York, April 22, 1904.

[2] "Modern Commutating Dynamo Machines, with Special Reference to the Commutating Limits," by H. M. Hobart, *Proceedings Institute Electrical Engineers*, vol. xxxi, p. 170.

[3] It is interesting to note that the end connections contribute more to the total inductance than the slots.

[1] "Design of Alternators," *Engineering*, vol. lxx, p. 107.

lect the inductance-flux as directly affecting the value of the resultant flux, and to employ it merely in deriving the angular distance between mid-pole position of the centre of one side of the armature coil, and the position corresponding to maximum value of the current in the armature coil. This theory gave very satisfactory results, checking observed values more closely than any other method available. But of course the present method which is supported by a sound theory, is distinctly preferable and gives, in fact, still higher accuracy.

In the predetermination of the characteristic curves, one has frequent occasion to employ the following values:

TABLE IV.

Type of Machine.	Rated Output in Kilowatts.	No. of Poles.	Periodicity (Cycles per Second).	Ampere-turns on the Field Spool.		Percentage Deviation between Calculated and Observed Results.
				Observed.	Calculated Out of Short-Circuited Current.	
Single-phase generator ...	75	8	60	4000	4560	14
"	120	14	125	2900	2840	2
"	100	20	60	2875	3030	5
"	60	10	125	2900	2800	3
"	300	32	125	3650	3510	4
"	180	20	125	3250	3070	5.5
"	150	20	125	2950	2890	2
Three-phase generator, Y-connected ...	360	12	60	3550	3880	9.3
"	300	12	35	5255	5050	4
"	225	6	25	6750	6300	7
"	150	14	60	3400	3500	3
Three-phase generator, Y-connected ...	150	12	60	4100	3940	4
"	75	20	25	4800	4900	2
"	250	24	25	7850	7930	1
"	100	12	60	3950	3900	1.5
"	150	12	60	3850	3850	0
"	250	16	60	3800	3800	0
"	200	48	40	5300	5550	5

Ohmic (i R) drop per ampere, 0.33 volt.
Reactance-pressure per ampere, 2.52 volts.
Demagnetizing ampere-turns per ampere $= 3 \times 0.77 \times 0.96 \times 14 \times \sin \phi' = 31 \sin \phi'$ (see table III).
Distorting ampere-turns per ampere $= 3 \times 0.17 \times 0.96 \times 14 \times \cos \phi' = 6.8 \cos \phi'$ (see table III).

Calculation of the armature interference for full load and $\cos \phi = 1$.

In the diagram of Fig. 9, the vectors have the following magnitudes:

$OE = 2{,}880$ volts.
$EB = 98.5 \times 2.52 = 248$ volts.
$BA = 98.5 \times 0.33 = 32.5$ volts.
$OA = \sqrt{(OE + BA)^2 + (AB)^2} = 2{,}915.$
Hence

$$\alpha = \sin^{-1} \frac{248}{2{,}915.}$$
$$= \sin^{-1} 0.08.$$
$$= 4.8 \text{ degrees.}$$

The distorting ampere-turns equal $8.6 \times 98.5 \times \cos \phi' = 670 \cos \phi'$.

ϕ' is not yet determined, but it is evidently small—of the nature of fifteen degrees—and hence $\cos \phi'$ is approximately equal to unity and the armature distortion to 670 ampere-turns.

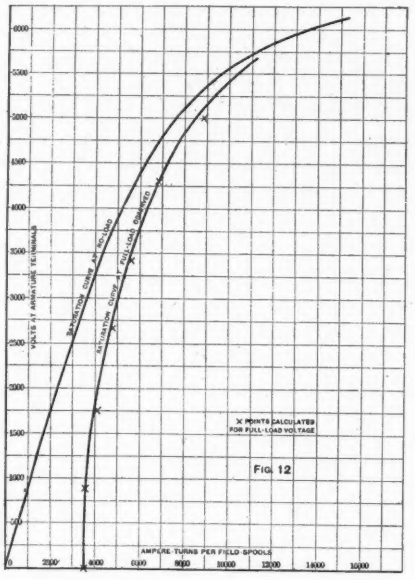


FIG. 12.

FIG. 12.—REGULATION OF ALTERNATORS.

For 2,915 volts per phase we see from the straight sloping line in Fig. 8 that the air-gap reluctance requires 5,600 ampere-turns. Hence β which equals

$$\frac{\text{Distorting ampere-turns}}{\text{Ampere-turns for air-gap}} \times 90 \text{ degrees}$$

is equal to

$$\frac{670}{5{,}600} \times 90 \text{ degrees} = 10.8 \text{ degrees.}$$

$\phi' = \alpha + \beta = 4.8 \text{ deg.} + 10.8 \text{ deg.} = 15.6 \text{ deg.}$[1]

The demagnetizing ampere-turns
$= 31 \times 98.5 \times \sin \phi'.$
$= 31 \times 98.5 \times 0.262.$
$= 800.$

From the saturation curve in Fig. 8 we find that 7,900 ampere-turns are required for 2,915 volts per phase. Hence the total field excitation required for full-load current of 98.5 amperes at unity power-factor is

$$800 + 7{,}900 = 8{,}700.$$

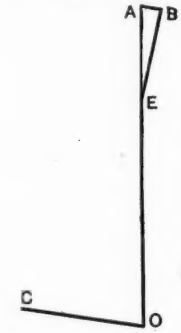


FIG. 13.—REGULATION OF ALTERNATORS.

But at this increased magnetomotive force the leakage coefficient of the magnetic circuit has also increased, and at the high saturation values often met with in modern alternators this may amount to a very appreciable influence, and we take account of it in our theory; though in the interests of simplicity, only in a roughly approximate manner, as anything approaching an exact estimation requires too much time[1] to be employed in practical designing work.

We follow Hopkinson's definition for the leakage coefficient, namely,

$$\text{Leakage coefficient} = \frac{\text{Useful flux} + \text{leakage flux}}{\text{Useful flux}};$$

the leakage flux is equal to a constant $\times$ the ampere-turns per field-spool multiplied by

$$\frac{h\,(b+15)}{a} \text{ (see Fig. 10)}$$

for cores of rectangular cross-section and by

$$\frac{h + b}{a}$$

for cores of circular sections.

The constant may be taken at about 1.7 per cent. It is assumed that pole-arc is between 0.55 and 0.70 of pole-pitch.

For no-load and 2,915 volts per phase we obtain a leakage coefficient equal to 1.20.[2]

At full load the leakage coefficient increases to

$$1 + 0.20 \times \frac{8{,}700}{7{,}900} = 1.22$$

In Fig. 8 are plotted, in addition to the right-hand curve of total saturation, two other curves, the intermediate one corresponding to the ampere-turns required for air-gap and teeth, and the left-hand curve corresponding to the ampere-turns required for magnet-core and yoke. For our purpose it has been sufficient to take the saturation for air-gap as a straight line through the origin tangent to the curve of total saturation, and to derive the curve for magnet core and yoke from the difference of the other two curves, taking into account the ampere-turns for the teeth at high saturation.

For a no-load potential of 2,915 volts per phase (OA of Fig. 9), 1,950 ampere-

[1] If greater accuracy should be considered desirable, one could, now that a better approximation of ϕ' has been obtained, make a final precise calculation of β as follows:

$$\beta = \frac{\cos 15.6 \text{ deg.}}{\cos 0 \text{ deg.}} \times 10.8 \text{ deg.}$$
$$= 0.963 \times 10.8 \text{ deg.}$$
$$= 10.40$$
and $\phi' = 4.8 \text{ deg.} + 10.4 \text{ deg.} = 15.2 \text{ deg.}$

[1] See Kapp's "Elektromechanische Konstruktionen," 1902, p. 28; Arnold, E. T. Z., 1902, p. 251.

[2] Ampere-turns per field-spool = 7,650.
$h = 25 \quad b = 37 \quad a = 15$
Total useful flux $= M = \frac{2{,}915}{4.44 \times 448 \times 25 \times 10^{-8}} = 5.8 \times 10^6$
Leakage coefficient $= 1 + \frac{1.7 \times 7{,}650 \times 25 = (37+15)}{5.8 \times 10^6 \times 15} = 120$

turns are, from the left-hand curve of Fig. 8, found to be required for magnet core and yoke. But so far as relates to the magnetomotive force required for magnet core and yoke, the increase in the leakage coefficient from 1.20 to 1.22 has the same effect as would result from an increase in voltage per phase from 2,915 to

$$\frac{1.22}{1.20} \times 2{,}915 = 2{,}960 \text{ volts}$$

with constant leakage coefficient. From the left-hand saturation curve of Fig. 8 it is found that for 2,960 volts, the magnet core and yoke would require 2,050 ampere-turns.

$$2{,}050 - 1{,}950 = 100 \text{ ampere-turns}$$

is the increased excitation required for magnet core and yoke in virtue of the increased leakage coefficient.

From this we finally find that a total magnetomotive force of

$$8{,}700 + 100 = 8{,}800 \text{ ampere-turns}$$

per field spool is required to obtain 5,000 terminal volts (2,880 volts per phase) for the full-load current of 98.5 amperes at unity power-factor.

To obtain the inherent regulation,[1] one compares the voltage per phase (2,880) thus obtained, with the pressure corresponding to the same excitation at no load.

This is found from Fig. 8 to be 3,030 volts, and the inherent regulation is therefore:

$$\frac{3{,}030 - 2{,}880}{3{,}040} \times 100 = 4.9 \text{ per cent.}$$

In this manner the field ampere-turns have been estimated for various pressures and various amperes output and the results are plotted in Fig. 11. Experimental confirmation of the upper curve (that for 2,880 volts per phase) is found in the group of observed points plotted in Fig. 11 for these conditions of load and pressure. In Fig. 12 the right-hand saturation curve for full-load current of 98.5 amperes at unity power-factor has been derived by observation, while the plotted points are taken from the calculated curves of Fig. 11. The left-hand curve of Fig. 12 is merely the no-load saturation curve which has been reproduced from Fig. 8.

CALCULATIONS FOR COS $\phi = 0$.

For a power-factor of zero, the calculations become exceedingly simple. The armature distortion becomes equal to zero, but the demagnetizing ampere-turns have a great influence upon the results. The ohmic drop can be altogether neglected because of its vector position, while the reactance pressure swings nearly into phase with the terminal pressure.

For full-load current of 98.5 amperes,

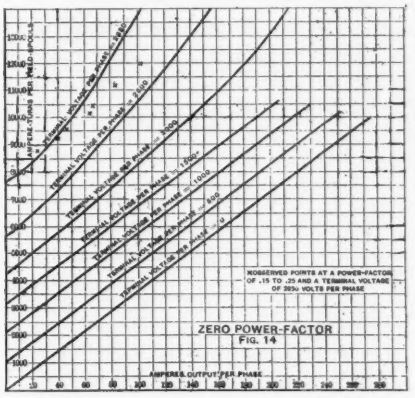


FIG. 14.—REGULATION OF ALTERNATORS.

the calculation is as follows (see Fig. 13):

EB = 248.

AO = OB (approximately) = OE + EB.
= 2,880 + 248 = 3,128.

Demagnetizing ampere-turns = 3,050.

Ampere-turns per field-spool required to generate 3,128 volts = 9,400.

Total = 3,050 + 9,400 = 12,450.

Leakage coefficient

$$= 1 + 0.20 \times \frac{12{,}450}{9{,}400} = 1.27.$$

Increase in excitation required in virtue of increased leakage coefficient = 4,100[1] − 3,000 = 1,100 ampere-turns.

Total excitation per field-spool required for 5,000 terminal volts (2,880 volts per phase), for 98.5 amperes output at cos $\phi = 0$ is, therefore,

12,450 + 1,100 = 13,550 ampere-turns.

Corresponding to the group of curves of Fig. 11 relating to cos $\phi = 1$, there has

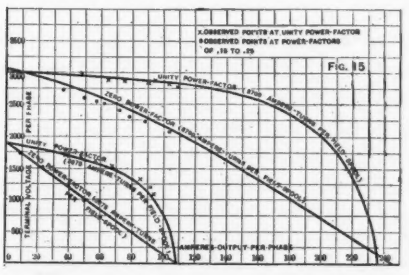


FIG. 15.—REGULATION OF ALTERNATORS.

been prepared for cos $\phi = 0$, the group of curves shown in Fig. 14. Experimentally observed points could, of course, not be obtained for cos $\phi = 0$, but a number taken for values of cos ϕ lying between 0.10 and 0.25 are given corresponding to the upper curve for 2,880 volts; *i. e.*, 5,000 terminal volts. These observed points lie somewhat below the calculated curve, and even when the difference in power-factor is taken into consideration, are slightly too low. This presumably arises from the tooth-saturation which for these conditions reached 17,500 lines per square centimetre, and occasioned a slight decrease in the inductance, below the short-circuit value, where the agreement was so excellent. The authors are not of opinion that a precise predetermination of the influence of the tooth-saturation is possible, as this has always been found with induction motors to be the case. Fortunately, also, the method, without consideration of the influence of the tooth-saturation on the inductance, gives much more precise results than are required in practice.

These groups of curves (Figs. 11 and 14) afford a simple means of deriving curves of the performance of an alternator under all conditions of load. Should one, for instance, wish to plot a curve showing the dependence of the terminal pressure on the current for constant field excitation, one draws a horizontal line corresponding to this constant value of the excitation, and the intersection of this line with the curves for different pressures gives at once sufficient points for plotting the desired curve. This has been done in Fig. 15 for four different cases, for which experimental data were also available. This agreement is very close.

For values of the power-factor intermediate between zero and unity, one carries out the calculation in the same manner as has been illustrated for cos $\phi = 1$. One employs for the purpose the vector diagram of Fig. 2, in order to calculate OA and the angle α it is preferable to employ the graphical method, taking the values directly from the diagram, and thus avoid the necessity for analytical calculations. β is obtained from the value of the armature distortion and one thus obtains

$$\phi' = \alpha + \beta + \phi$$

The remainder of the calculation proceeds in precisely the same manner as for cos $\phi = 1$ and cos $\phi = 0$.

The authors are of the opinion that in the course of time it will become customary to specify merely the regulation for a pure inductance load; for, just as in the calculations this was shown to be the simplest case to handle, so also is it in practice, the case which can be most

[1] We define the "inherent regulation" for a given power-factor, as the percentage increase in pressure occurring when the load is decreased from rated full-load current to no load, the excitation remaining constant.

The "excitation regulation" is also a useful conception, and for a given power-factor is defined as the percentage increase in the excitation required to maintain constant terminal pressure, as the load is increased from no load to rated full-load amperes.

[1] 4,100 and 3,000 are the excitations for magnetic core and yoke corresponding respectively to $\frac{1.27}{1.20} \times 3{,}128 =$ 3,300 and to 3,128 volts.

cheaply, simply and accurately experimentally determined.

For approximately unity power-factor, it is exceedingly difficult, even with the best of wattmeters and other measuring instruments, to demonstrate the presence or absence of a slight difference of phase, and to measure it, although such a slight phase difference has a great influence on the regulation. For very low power-factors, *i. e.*, for $\cos \phi = 0$ as the limit, a phase difference of from twenty degrees to thirty degrees only slightly influences the result. Furthermore, for tests with $\cos \phi = 1$, a certain fall in speed is difficult to avoid when throwing on the load. For the same current at a low power-factor this difficulty in an experimental determination of the pressure regulation is avoided.

All these factors tend to make the introduction of the percentage inherent regulation at $\cos \phi = 0$ as an important criterion of the design, a very desirable step. Should such a course be adopted generally, it would perhaps be necessary specially to consider those factors that may make the inherent regulation, at unity power-factor, poor, without impairing the inherent regulation at zero power-factor. These factors are:

1. The ohmic drop.

2. The ratio of pole-arc to pole-pitch.

The influence of the ohmic drop amounts in the design we have considered to about twenty-five per cent of the inherent regulation at $\cos \phi = 1$, and is negligible at $\cos \phi = 0$. Therefore it is necessary to specify the ohmic drop separately, and a resistance measurement with direct current at the final temperature of the generator is quite sufficient for the purpose.

The ratio of pole-arc to pitch may have a decided effect, if quite abnormal dimensions are adopted; but inasmuch as other considerations, especially increased magnetic leakage, would prevent the use of a high ratio, the writers propose, for simplicity's sake, to disregard this factor. The writers put forward, therefore, the following specification as regards inherent regulation:

The generator shall, when loaded with the full rated current, lagging in phase behind the pressure by an angle corresponding to a power-factor of less than 0.2, at the temperature which the generator attains after ten hours' full-load working, increase its normal pressure by no more than — per cent, when the load is thrown off.

The ohmic drop, calculated with rated full-load current, and a resistance determined experimentally at the final temperature with direct current, shall not amount to more than — per cent.

The calculation of these data may be briefly repeated in tabular form:

Output at unity power-factor	850 kw.
Type of winding	Y
Pressure per phase	2380
Amperes per phase at full load	98.5
Number of armature-turns per phase	448
Number of poles	32
Number of armature-turns per pole and per phase	14
Number of effective armature ampere-turns per pole and per phase	1380
Ratio of pole-arc to pole-pitch	0.63
Space taken by one side of the winding, per pole and per phase in per cent of pole-pitch.	33%
Breadth-factor (B)	0.95
Demagnetizing ampere-turns per ampere	31
Demagnetizing ampere-turns at full load (a)	3500
Number of slots	192
Number of slots per pole and per phase	2
Depth of slot (D)	9.2 mm.
Depth of slot above winding space (d)	1.2 "
Width of slot at the root	3.3 "
Width of slot at the end	3.3 "
c.g.s. lines per ampere-turns per cm. length of winding in one slot	1.99
Additional lines in case of half open slots	—
Total lines per cm. length of winding in one slot	1.99
c.g.s. lines per ampere-turns per cm. length of effective winding	1.00
c.g.s. lines per ampere-turns per cm. length of free winding	0.7
Length of one turn in iron (effective length)	55 cm.
Length of one turn in air (free length)	106 "
c.g s. lines per ampere-turns due to effective length of a turn	55
c.g.s lines per ampere-turns due to free length of a turn	74
c.g.s. lines per ampere-turns	129
Inductance of one coil	0.001 henry
Reactance of one coil	0.157 ohm
Reactance of all coils per phase	2.51 "
Reactance pressure per ampere	2.51 volts
Reactance pressure per phase at full load	248 "
Total internal pressure	3128 "
Ampere-turns required for internal pressure (A)	9400
Demagnetizing ampere-turns (a)	3050
$A + a$	12450
Shape of magnet cross-section	rectangular
Width of magnet	37 cm.
Radial length of magnet core	25 "
Smallest distance between magnet cores midway along their length	15 "
Leakage c.g.s. lines corresponding to internal pressure	$= 1.24 \times 10^6$
Useful flux	6.2×10^6
Leakage coefficient	1.20
Leakage coefficient corresponding to internal pressure ampere-turns + demagnetizing ampere-turns	1.27
Ampere-turns for (field + yoke) corresponding to internal pressure	3000
Ampere-turns for (field + yoke) corresponding to the increased leakage factor	4100
Difference in ampere turns (C)	1100
Ampere-turns per internal volt	9400
Demagnetizing ampere-turns	3050
Total ampere-turns at full load	13350
Internal pressure (E) corresponding to total calculated ampere-turns at no load	343 volts
Inherent regulation at zero power-factor	23%
Inherent regulation at power-factor up to 0.20 (estimated)	21%
Length of one turn	1.61 cm.
Total length of the turns of one phase	720 "
Cross section of one conductor	44.2 sq. cm.
Cross section of all parallel conductors	44.2 " "
Resistance of one phase at 60°	0.33 ohm
Ohmic drop per phase per ampere	0.33 volt
Ohmic drop per phase at full load	32.6 "
Ohmic drop in per cent of pressure per phase	1.13%

APPENDIX I.

Derivation of the tables set forth in table I, and consideration of the general solution for any wave-form of electromotive force and current.

We have considered the case of armature interference due to a single conductor per pole, traversed by a constant current of i amperes, the conductor occupying a fixed position opposite the pole. (See Figs. 3 to 6.) But of course the occurrence in a dynamo consists in the flow of an alternating current in the conductor and the conductor moves past the pole at a rate corresponding to the frequency of this alternating current. Hence the amount of the interference of the armature magnetomotive force instead of being constant varies from instant to instant. The magnetic flux will tend to respond to these variations in the armature magnetomotive force, but in so far as it responds, it generates eddy currents, so that the amplitude of these periodic variations in the magnetic flux is very small in comparison with the amplitude of the periodic variations in the total magnetomotive force. Thus it is justifiable to assume a mean magnetic flux corresponding to the mean total magnetomotive force. For various symmetrically situated positions of the conductor, we calculate the armature interference in the manner already illustrated and take a mean of these results for the final value. We shall now explain the derivation of this mean value for the case of a single-phase alternator with one slot per pole, on the assumption of a sine curve of current.

If we let the slot contain $2n$ conductors, we have n ampere-turns per pole. Letting i denote the effective armature current, then evidently:

$ni\sqrt{2}$ = maximum armature ampere-turns per pole. Let us subdivide the pitch into ten sections corresponding to the values

$$x = 0, \quad x = \frac{\tau}{10}, \quad x = 2\,\frac{\tau}{10}, \text{ etc.}$$

and let us first consider the case where maximum current is reached when the conductor reaches mid-pitch position. One sees at once that in this case the total number of magnetic lines is not affected by the armature interference, *i. e.*, the demagnetizing ampere-turns are equal to zero. Hence, in our formula

$$y = \tfrac{1}{2}\,\frac{x\,(b - x)\,i}{\mathrm{A}\,b - (i\,b/2) + x\,i}$$

Since we have two n conductors for every one conductor of the elementary case, the formula now reads

$$y = \tfrac{1}{2}\,\frac{x\,(b - x)\,i \times 2\,n}{\mathrm{A}\,b - n\,i\,b + 2\,x\,i\,n}$$

or, reduced

$$y = \frac{x\,(b - x)\,i\,n}{\mathrm{A}\,b - n\,i\,b + 2\,x\,i\,n}$$

the denominator, which as we have seen, represents the entire surface, remains constant. In order to derive the average value of the armature distortion we have only to consider the variable numerator.

$$x\,(b - x)\,i\,n$$

The calculation can best be arranged in tabular form and this is done in table A for the case of fifty per cent pole-pitch, n turns per pole and one slot per pole.

TABLE A.

CALCULATION OF ARMATURE DISTORTION FOR THE CASE OF A UNI-SLOT ALTERNATOR WHERE MAXIMUM CURRENT IS REACHED WHEN THE CONDUCTORS OCCUPY THE MID-POLE POSITION.

Ratio of pole-arc to pitch equals fifty per cent. Distance from centre of the armature magnetomotive force to mid-pole position equals 0.

X Distance of Group of Conductors from Mid-Pole Position.	$b - X$	Magnetomotive Force of One Group of Conductors, in Ampere-Turns, at Different Positions.	$x\,(b-x)\,i\,n$ [the product of the values in the first three columns.]
0	$5\,\tau/10$	$n\,i\,\sqrt{2}\times 0.71$	0
$1\times\tau/10$	$4\times\tau/10$	$n\,i\,\sqrt{2}\times 0.89$	$n\,i\,\sqrt{2}\ 3.55\ (\tau/10)^2$
$2\times\tau/10$	$3\times\tau/10$	$n\,i\,\sqrt{2}\times 0.99$	$n\,i\,\sqrt{2}\ 5.92\ (\tau/10)^2$
$3\times\tau/10$	$2\times\tau/10$	$n\,i\,\sqrt{2}\times 0.99$	$n\,i\,\sqrt{2}\ 5.92\ (\tau/10)^2$
$4\times\tau/10$	$1\times\tau/10$	$n\,i\,\sqrt{2}\times 0.89$	$n\,i\,\sqrt{2}\ 3.55\ (\tau/10)^2$
$5\times\tau/10$	$0\times\tau/10$	$n\,i\,\sqrt{2}\times 0.71$	0

In table A the distorting effect of the component group of conductors when lying under the pole face has been estimated. It has already been mentioned that the conductors when not lying under the pole face exert no distorting influence; hence we obtain the average value for

$$x\,(b-x)\,n\,i$$

by adding together the six values in the last column of table A, and dividing by ten, the total number of sections into which the pitch τ has been subdivided.

This average value is

$$1.9\,i\,n\,\sqrt{2}\,(\tau/10)^2 = 0.027\,i\,n\,\tau^2$$

The magnetic centre has therefore been shifted by the amount

$$y = \frac{0.027\,i\,n\,\tau^2}{\mathrm{A}\,.\,b} = \frac{0.027\,i\,n\,\tau^2}{0.5\,\mathrm{A}\,\tau} = 0.054\,\left(\frac{i\,n}{\mathrm{A}}\right)\tau$$

We must next proceed to consider the case where the centre of the group of armature conductors is at a distance $\tau/10$ from the pole centre at the instant when maximum current flows. Thus it now becomes necessary to consider the alteration not only in the form of the flux distribution but also in its amounts.

The change in magnitude, $i/2$ the armature demagnetization is dependent upon the expression

$$(b - 2\,x)\,n\,i\,[1]$$

With reference to table A we have stated that the conductors only cause a distortion of the field when lying under the pole face, and have hence considered only these positions of the conductors in estimating the distortion. But in estimating, the decrease in the total flux, armature conductors in all positions have to be taken into account. One sees this best by considering Figs. 6 and 10. x is taken as positive in the direction from A to B (Fig. 10). We may integrate from A to D or from one to the next of any other two points separated from one another by a distance equal to the pitch. In all cases where these conditions are complied with, the same result will be obtained. The plan pursued in deriving the following tables has been to integrate between points C and B. $b\,i$ is derived by calculating the mean magnetomotive force in ampere-turns exerted by the armature conductors in moving from B to C.

BC is divided into ten parts and as we know that the maximum value of the sine wave of current occurs when the conductor is distant by $\tau/10$ from the mid-pole position, one can readily derive the corresponding values for all the other positions and thus obtain the mean value, which is

$$0.400\,(i\,n)\,\tau$$

The value $2\,x\,n\,i$[1] must of course also be obtained from the mean of this same range of positions, *i. e.*, from B to C, x being taken as positive in the direction AB from A. But the influence of the conductors when lying between A and C is evidently zero, since the air-gap may be taken as infinitely great. Hence, we have, just as in table A, to consider only the conductors lying directly under the pole-arc.

So we again take ten symmetrically situated positions, of which only the values for the five lying between A and B need to be calculated, while in the remaining positions

$$2\,x\,n\,i = 0$$

TABLE B.

CALCULATION OF $2\,x\,n\,i$ IN OBTAINING THE ARMATURE DEMAGNETIZATION FOR THE CASE WHERE MAXIMUM CURRENT IS REACHED WHEN THE CONDUCTORS OCCUPY A POSITION DISTANT BY $\tau/10$ FROM MID-POLE POSITION.

x Distance of Group of Conductors from Mid-Pole Position.	Magnetomotive Force of One Group of Conductors, in Ampere-Turns, at Different Positions.	$2\,x\,n\,i$ *i. e.*, the Product of the Values in the First Two Columns.
0	$i\,n\,\sqrt{2}\times 0.89$	0
$\tau/10$	$i\,n\,\sqrt{2}\times 0.99$	$0.099\,\sqrt{2}\,(n\,i)\,\tau$
$2\,\tau/10$	$i\,n\,\sqrt{2}\times 0.99$	$0.198\,\sqrt{2}\,(n\,i)\,\tau$
$3\,\tau/10$	$i\,n\,\sqrt{2}\times 0.89$	$0.267\,\sqrt{2}\,(n\,i)\,\tau$
$4\,\tau/10$	$i\,n\,\sqrt{2}\times 0.71$	$0.284\,\sqrt{2}\,(n\,i)\,\tau$
$5\,\tau/10$	$i\,n\,\sqrt{2}\times 0.455$	$0.227\,\sqrt{2}\,(n\,i)\,\tau$

A summation of the values in table B gives us

$$1.36\,(n\,i)\,\tau$$

Hence, the mean value of $2\,x\,n\,i$ is

$$\frac{1.36\,(n\,i)\,\tau}{10} = 0.136\,(n\,i)\,\tau$$

and we at once obtain the distortion as

$$(b - 2\,x)\,n\,i = 0.400\,(n\,i)\,\tau - 2\,x\,0.136\,(n\,i)\,\tau = 0.128\,(n\,i)\,\tau$$

The shifting of the magnetic centre (*i. e.*, the armature distortion) is calculated just as in table A, and as it is only the final results which are of interest, this calculation will not be repeated here. The results of these calculations are brought together in table C.

TABLE C.

POLE ARC = 50 PER CENT OF PITCH.

ϕ' Distance from Pole Centre to the Position Where the Current in the Armature Coil Is a Maximum.	Decrease in Flux Expressed by $(b-2\,x)\,n\,i$ *i. e.*, the Armature Demagnetization.	Corresponding Values for a Sine-Curve Assumption.	Amount of Shifting of Centre of Magnetic Flux Expressed by $x\,(b-x)\,n\,i$ *i. e.*, the Armature Distortion.	Corresponding Values for a Sine-Curve Assumption.
		$0.41\sin\phi'$		$0.027\cos\phi'$
0	0	0	$0.027\ (i\,n)\tau^2$	0.027
$\tau/10$	$0.128\ (i\,n)\tau$	0.127	$0.0254\,(i\,n)\tau^2$	0.0256
$2\,\tau/10$	$0.24\ (i\,n)\tau$	0.241	$0.0217\,(i\,n)\tau^2$	0.0219
$3\,\tau/10$	$0.33\ (i\,n)\tau$	0.331	$0.0158\,(i\,n)\tau^2$	0.0159
$4\,\tau/10$	$0.39\ (i\,n)\tau$	0.404	$0.0079\,(i\,n)\tau^2$	0.0084
$5\,\tau/10$	$0.41\ (i\,n)\tau$	0.41	0	0

As one sees from the table, the agreement with the sine curve is practically perfect, and we are fully justified in drawing the conclusions expressed in the two following equations:

$(b - 2\,x)\,n\,i = 0.41\,(n\,i)\,\tau\sin\phi'$
= armature demagnetization.

$x\,(b-x)\,n\,i = 0.027\,(n\,i)\,\tau^2\cos\phi^2$
= armature distortion.

In the same way the corresponding values for a pole-arc equal to seventy per cent of the pitch, have been found to be

$(b - 2\,x)\,n\,i = 0.52\,(n\,i)\,\tau\sin\phi'$
= armature demagnetization.

$x\,(b-x)\,n\,i = 0.0707\,(n\,i)\,\tau^2\cos\phi'$
= armature distortion.

We have now arrived at the stage where we may drop the original assumption of a magnetic material without reluctance, and we will examine into the alterations thereby involved; up to this point we have reckoned throughout on the basis of the magnetic flux having only to cross the air-gap, so far as relates to the reluctance encountered. Now, those magnetic lines which must also traverse magnet core and yoke will thereby have to encounter a much greater reluctance than we have up to this point assumed.

Much the simplest way of taking ac-

[1] $(b-2x)\,n\,i$ is the area by which the original area $A\,b$ is diminished by the armature demagnetization. This is evident from Fig. 5.

[1] *i. e.*, $2x$ (armature ampere-turns per pole).

count of this influence, is to alter the expressions from magnetic flux to magnetomotive force. It should be observed that this only applies to that portion of the magnetic flux which traverses magnet and yoke; for that portion which only brings about a shifting of the magnetic field, the retention of the magnetic lines is correct. Nevertheless, in order to preserve uniformity in expression we shall also transfer the latter into equivalent magnetomotive force, employing, not the total field magnetomotive force A but the magnetomotive force A^1 (in ampere-turns), which is necessary to drive the magnetic flux across the air-gap. That portion of the armature magnetomotive force which acts to change the magnitude of the magnetic flux is denoted by armature demagnetization, and that which acts to change its position, by armature distortion.

Returning now to the example which we have been considering, we have

Armature demagnetization (for $b = 0.5\ \tau$)
$= 0.82\ (i\ n) \sin \phi'$

Armature demagnetization (for $b = 0.7\ \tau$)
$= 0.75\ (i\ n) \sin \phi'$

Armature distortion (for $b = 0.5\ \tau$)
$= 0.108\ (i\ n) \cos \phi'$

Armature distortion (for $b = 0.7\ \tau$)
$= 0.202\ (i\ n) \cos \phi'$

While the armature demagnetization must be deducted directly from the field magnetomotive force, one employs the armature distortion to determine the displacement of the magnetic centre, expressing this either in the form:

$$y = \frac{\text{Armature distortion}}{\text{Gap ampere-turns}} \times \tau/2$$

or in degrees:

$$\beta = \frac{\text{Armature distortion}}{A^1} \times 90^\circ$$

or,

$$\beta = \frac{\text{Armature distortion}}{\text{Gap ampere-turns}} \times 90^\circ$$

Electrification of the Tunnels under the Alps.

The European technical press reports that the question of operating the various railroads through the Alpine tunnels electrically is being seriously discussed in Switzerland. The Erstfeld-Bellinzona section has been used for experimental work, and the results obtained promise economy in the working of the whole Gothard line, so that the adoption of electric traction may be expected before long. It is said that steam traction costs about twenty-two cents per train-mile there, while the highest estimate for electric traction does not place it at more than eighteen cents. The use of electric traction in the Simplon tunnel is also being discussed.

Honoring a Distinguished Newspaper Man.

Mr. Melville E. Stone, general manager of the Associated Press and president-elect of the Illinois Society of New York, was tendered a dinner by the society at Delmonico's Saturday evening, April 30. About two hundred friends of Mr. Stone were present, including many distinguished in public life and in journalistic and financial circles. Mr. Henry D. Estabrook, general counsel of the Western Union Telegraph Company, was the able toastmaster, and several interesting and eloquent speeches were delivered by ex-Secretary Lyman J. Gage, ex-Postmaster-General Charles Emory Smith, the Rev. Dr. Ernest M. Stires, the Hon. Whitelaw Reid, James M. Beck, and others.

Mr. Stone in responding, made an eloquent tribute to the loyalty of his staff, and speaking touchingly of the boys on the danger line in the Russian-Japanese War, said:

"I am proud of the gentlemen who are associated with me, I shall never cease, so long as I live, to have not only pride in them, but the profoundest possible respect, a respect for the men who are going out to-night between two armies scarcely civilized, from our point of view, taking their lives in their hands, conscious that if they happen to be with the defeated party, death is almost certain.

"And, gentlemen, there are a number of men out on the borders of the Yalu river to-night who have not the consolation of a gun to defend themselves with, and who are at the forefront to write the news of the Associated Press that you may enjoy it to-morrow morning."

Among those present in addition to the speakers were Colonel Robert C. Clowry, A. B. Chandler, George G. Ward, Arthur Brisbane, Charles W. Price, Louis Wiley, Thomas J. Ryan, T. C. McClure, B. Brooks, J. C. Barclay, A. Davidson, Charles A. Moore, F. B. Schenck, G. W. Rogers, Herman Ridder, Adolph S. Ochs, John Norris, Don C. Seitz, Bradford Merrill, E. P. Call, William C. Bryant, Frank R. Lawrence, E. C. Bradley, Geo. E. Marcus, J. Q. Mitchell, John A. Sleicher, C. H. Boynton, V. P. Snyder, and others.

The compliments for the honored guest of the evening were of a nature to have turned the head of a younger man, and yet were thoroughly deserved by Mr. Stone, whose able and far-seeing management of the Associated Press—the greatest news gathering organization in the world—has placed it on a particularly high plane, one it never before reached. His recent success in securing the removal of the Russian censorship, through a personal interview with the Czar, was especially spoken of by several of the speakers, and is a source of much gratification to the press of the United States.

Automobile Parade.

The first annual automobile parade of the Automobile Club of America was held on April 30, 1904. It is unfortunate that the early part of the day was marred by a severe rain-storm, which made necessary a delay of several hours in the start. Hundreds of automobiles of every type were in line, and in addition to the automobile drivers, there were a number of guests carried in the different vehicles. The electric vehicle was strongly represented, and universal commendation of this type of wagon was heard everywhere along the line. Among the storage battery companies represented by having their equipments installed in various vehicles were the Electric Storage Battery Company, Philadelphia, Pa.; Gould Storage Battery Company, New York, N. Y.; the National Battery Company, Buffalo, N. Y., and the Edison Storage Battery Company, Orange, N. J.

After the parade, the guests of the club, participating club members and all owners carrying guests were entertained informally at luncheon at the clubhouse. Credit is due to Mr. Emerson Brooks, chairman of the runs and tours committee, and to Mr. George B. Adams, marshal, for the success of this first annual parade.

The Edison Medal.

The American Institute of Electrical Engineers, through Mr. B. J. Arnold, its president, has issued a circular letter to the educational institutions of the United States of America and the Dominion of Canada. This calls attention to the organization of the Edison Medal Association and the creation of the fund to establish the Edison medal. The fund has been deposited with the Continental Trust Company of New York, and there will be available this year sufficient funds for a medal, which will be awarded by a suitable committee of the Institute which is soon to be appointed. The object of the letter is to attract the attention of the authorities of such institutions as may be qualified to compete, and the request is made that all institutions send through their proper channels their names to "The Edison Medal Committee" of the American Institute of Electrical Engineers, on or before June 1, 1904, in order that the committee may have before it the names of all institutions and those in direct authority.

The Edison medal committee is being selected from among the members of the Institute who are not now connected with educational institutions, but who have the necessary early educational training and subsequent experience to enable them to critically analyze and justly determine the merits of the theses offered in the various fields of research.

The Louisiana Purchase Exposition.

The Formal Opening, with Imposing Ceremonies, of the World's Fair at St. Louis, April 30, 1904.

THE Louisiana Purchase Exposition was formally declared opened at 1.04 o'clock Saturday afternoon, April 30. Throughout the exercises the weather remained clear, and there was nothing to mar the enjoyment of the throngs of spectators who had gathered to witness the formal ceremonies of dedi-

THE HON. THEODORE ROOSEVELT, PRESIDENT OF THE UNITED STATES OF AMERICA.

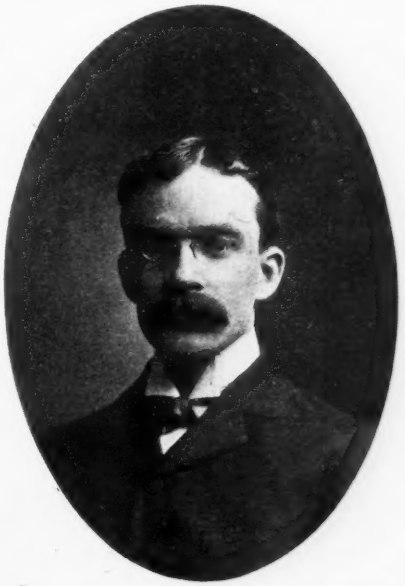
cation and turning over of the buildings to the respective chiefs of departments. The official hour for the beginning of the exercises was nine o'clock. At this time the officials of the exposition, members of the national commission and of the board of lady managers, and Secretary-of-War William H. Taft, representing the President of the United States, were scheduled to meet at the Administration Building. As rapidly as possible a procession was formed, and the march was begun to the plaza of St. Louis, in the centre of the grounds. Here the formal exercises of the opening took place. At the head of the column was a detachment of Jefferson Guards, who are doing police duty within the exposition grounds. As the column from the Administration Building entered the plaza, another procession, formed of representatives of foreign governments, which had assembled in the Hall of Congresses, entered the plaza from another avenue. Following this line came commissioners and representatives of foreign governments which have ambassadors accredited to the United States. In order there followed representatives of governments having ministers accredited to the United States, and then a number of other representatives of foreign governments and colonies, in the order of presentation of credentials to the exposition. The third column, which came shortly afterward, was formed of representatives of the states and territorial governments in the Union.

The assemblage was called to order by President David R. Francis of the exposition, and the audience arose while the Rev. Frank W. Gunsaulus, of Chicago, delivered the invocation. President Francis, as the chief executive of the exposition, delivered the opening address, and at its conclusion recognized William H. Thompson, of the committee on grounds and buildings, who presented to President Francis Mr. Isaac S. Taylor, the director of works. Mr. Taylor delivered to President Francis the key of the exposition, and presented diplomas of merit to the chiefs of his staff. President Fran-

THE HON. DAVID R. FRANCIS, PRESIDENT LOUISIANA PURCHASE EXPOSITION.

cis transferred the exposition buildings to Frederick J. V. Skiff, director of exhibits, this performance being emblematic of the fact that the buildings had beeen erected by the men in charge of that part of the work, and were now ready and waiting for the installation of the exhibits by Mr. Skiff's department. Mr. Skiff then addressed the assembly, and, following this, the grand chorous "Hymn of the West" was sung.

Mayor Rolla Wells, of St. Louis, was introduced, and he spoke briefly, extending to the people of the United States and the residents of countries abroad a cordial welcome to the city of St. Louis.



PROFESSOR W. E. GOLDSBOROUGH, CHIEF DEPARTMENT OF ELECTRICITY.

The Hon. Thomas H. Carter, president of the national commission, spoke on behalf of the body of which he is at the head. At the conclusion of Senator Carter's address, President Francis introduced Senator Henry E. Burnham, of New Hampshire, on behalf of the United States Senate. Congressman James A. Tawney, of Minnesota, spoke for the national house, and he was followed by Mr. Edward H. Harriman, president of the New York state commission, who spoke on behalf of the domestic exhibitors.

Commission-General Albine R. Nuncio, of Mexico, spoke for the foreign exhibitors, and then the Hon. William H. Taft, as representative of the United States, delivered the last address of the day.

At the conclusion of Secretary Taft's address, President Francis announced that he would communicate with the White House in Washington and inform the President that the hour and minute had arrived for turning on the power of the universal exposition of 1904. The following message was then sent: "President D. R. Francis presents his compliments to the President of the United States, and

begs to say that the management of the Louisiana Purchase Exposition awaits the pleasure of President Roosevelt, who is to transmit the electrical energy to unfurl the flags and start the machinery of the great exposition."

At one o'clock Saturday (Washington time) President Roosevelt and members of the cabinet, nearly all of the members of the diplomatic corps, with many ladies and several leading members of Congress, gathered in the East Room to open the Louisiana Purchase Exposition. Just before pressing the button, the President read the message noted above. As soon as the key was touched, the firing of a salute was begun by the artillery at the Washington barracks. Guests in the East Room applauded the opening of the fair, and the Marine Band played in the main corridor of the White House immediately before and after the ceremony of opening.

THE TERRITORY OF THE LOUISIANA PURCHASE.

All arrangements had been perfected by the Postal-Telegraph company in setting up the proper circuits. To guard against possible interference by storms in any particular section of the country, two separate circuits had been arranged for. The first ran from Washington through Cumberland, Baltimore, Pittsburg and Indianapolis to St. Louis, and the other from Washington through Baltimore, Philadelphia, Harrisburg, Pittsburg, Cleveland and Chicago to St. Louis.

As soon as the key was pressed, the flags were unfurled and the machinery started in a number of the exposition buildings. At the same time the water was released from the fountains in the cascade, and congratulatory messages were exchanged between Washington and the exposition officials.

The present exhibition celebrates the centennial of an event which, next to the Declaration of Independence, is probably the most important in the history of the United States. What was the Louisiana Territory at the time of its purchase in 1803 may be described as a great tract of land lying between the Mississippi river and the crest of the Rocky mountains. This territory stretches to an extent of over 1,000,000 square miles. The accompanying map shows the relative area of the original thirteen colonies, the territory purchased from France in 1803, and the total area of the present-day United States of America. The treaty which consummated the purchase from Napoleon Bonaparte, first consul of France, was signed at Paris, April 30, 1803. The formal transfer of the territory was made at New Orleans on December 30, 1803, and for upper Louisiana, at St. Louis, March 10, 1804. Diplomatic credit for this epoch-making event must, of course, be given first to Thomas Jefferson, then president of the United States, and his colleagues, Robert B. Livingston, minister to France from 1801 to 1804, and James Monroe, commissioner to France, 1803, and president of the United States from 1817 to 1825.

The Missouri Historical Society in 1898 initiated the first organized action in contemplation of a Louisiana Purchase Exposition. Governor Stevens, of Missouri, in response to a strong public sentiment, called a convention of delegates from the twelve states and two territories embraced in the Louisiana Purchase. This convention was called in St. Louis, January 10, 1899. Ninety-three delegates, appointed by their respective governors, attended and voted to hold an international exposition in St. Louis. The convention proposed that the United States Government be invited to assist in the enterprise, and appointed an executive committee, with the Hon. David R. Francis as chairman. This committee appointed a committee of fifty prominent citizens of St. Louis, to cooperate with it, and the united body formulated a plan for raising the money to defray the expense of the enterprise. The amount to be secured was fixed at $15,000,000, this being the sum paid to France by the United States for the territory. One-third of this amount was to be raised by private subscription, one-third was to be paid by the city, and one-third was to be asked for from the United States Government. On June 4, 1900, Congress passed a bill in which government support and an appropriation of $5,000,000 were promised, if the citizens of St. Louis raised $10,000,000. On January 12, 1901, a popular subscription of $5,000,000 from the citizens of St. Louis was completed, and on January 30, 1901, the municipal assembly of St. Louis passed an ordinance authorizing the issuance of city bonds to the amount of $5,000,000. The bill appropriating $5,000,000 was passed by the House of Representatives on February 9, and by the United States Senate on March 3, 1901. The bill was immediately signed by President McKinley, and a national commission of nine members was appointed on March 12.

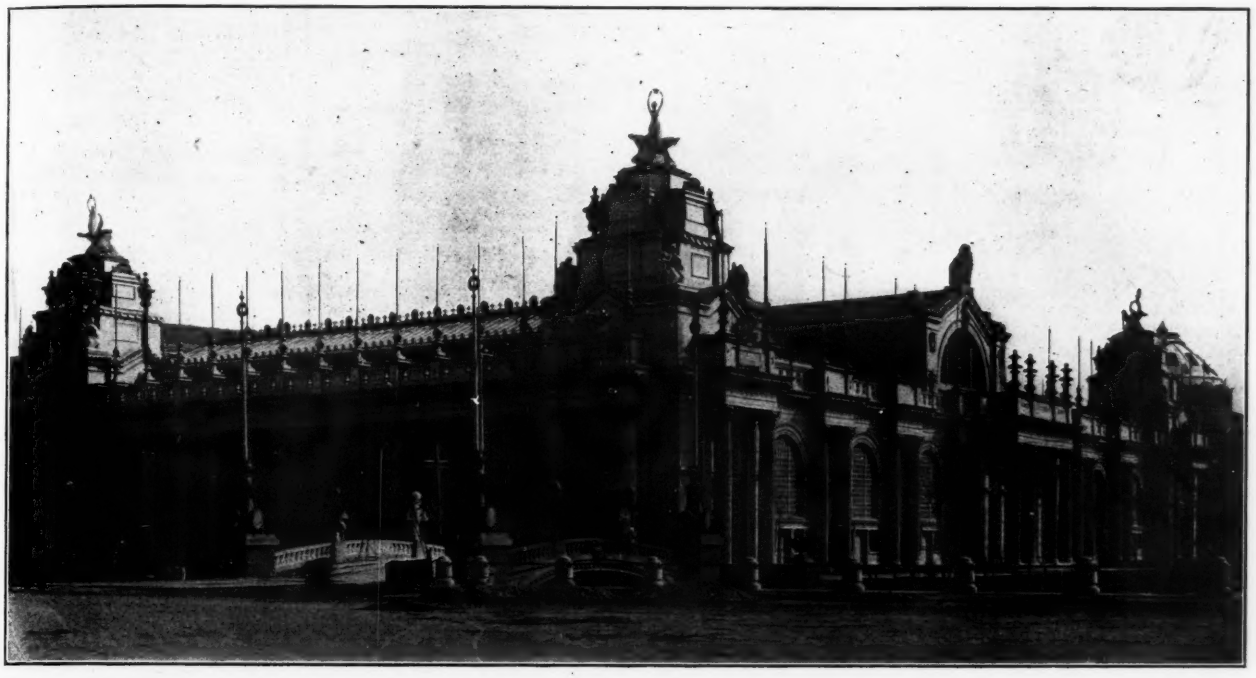
Later, Congress appropriated $1,500,000 for a government exhibit. The state of Missouri made an appropriation of $1,000,000, and other states voted sums for representation, altogether $60,000,000 having been appropriated for the exposition.

Comparing the area covered by the St. Louis Exposition with that covered by others which have been held heretofore, the present exposition is the greatest in the history of the world. The World's Fair buildings at Chicago in 1893 covered 200 acres of ground, the Paris Exposition in 1900 covered 125 acres, while the present exposition covers over 250 acres of ground. This is for the area covered by the buildings exclusively, the total area of the fair grounds exceeding 1,200 acres.

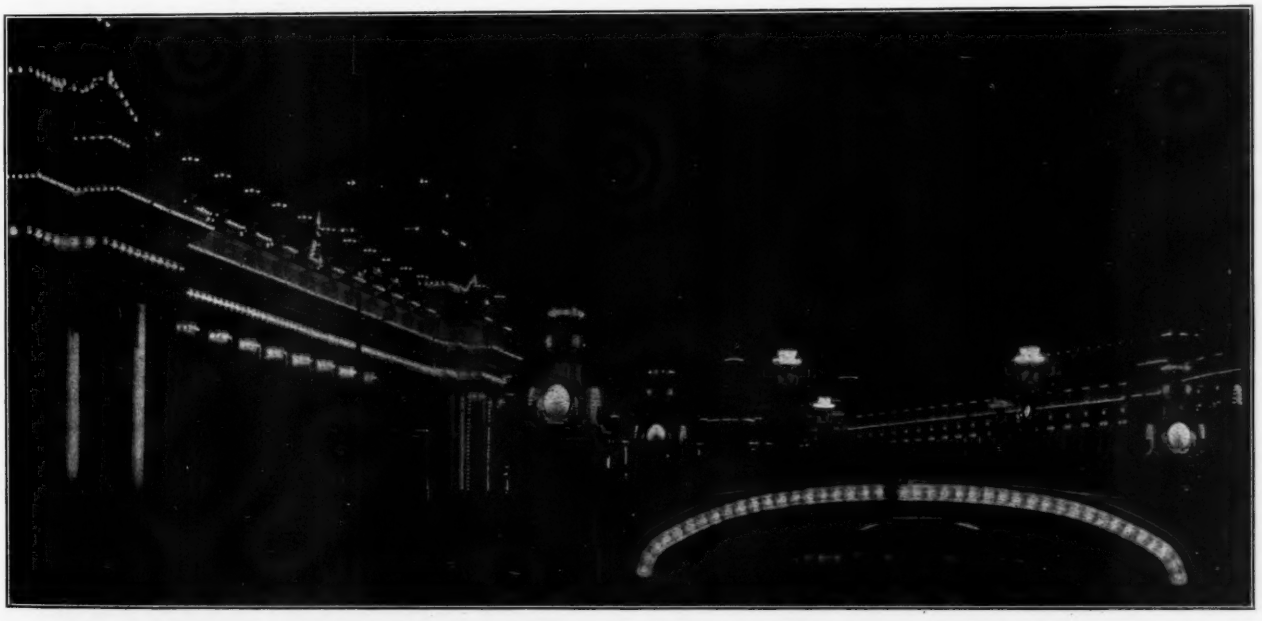
Ever since its inception, electrical apparatus has attracted considerable attention in both national and international exhibits. The exploitation of the speaking telephone at the Philadelphia Centennial in 1876 gave this electrical contrivance more prominence than it could have

achieved in any other way for many years. As the art has advanced, the exhibits have become more costly and more numerous. The Columbian Exposition at Chicago in 1893 brought forward many classical advances in the field of electricity. The Paris Exposition in 1900 showed a remarkable advance over the Columbian exhibit, and so on at the Pan-American, at Dusseldorf, and at minor expositions, electrical and kindred apparatus have become features of the first importance. By reason of its numerous ramifications, electricity is one of the chief features of the exposition just opened. Commensurate with its importance, the magnificent Electricity Palace spreads over an area of nine acres. In this building are housed all forms of apparatus depending upon electricity, from delicate electrotherapeutic contrivances and measuring instruments to ponderous current-producing and transforming machines. Not only is the apparatus shown as individual elements of machine construction, but the application of electricity to every phase of industrial activity is demonstrated by placing the machinery in actual service.

Representative manufacturers from all parts of the world have exerted every effort and spared no expense to make their exhibits as complete as possible. The immense power plant of the exposition, going hand in hand with the electrical exhibits, furnishes a close-range view of the possibility of these forms of power when used as auxiliary. All of the power used in the exposition to drive the exhibit machinery, and also furnish current for



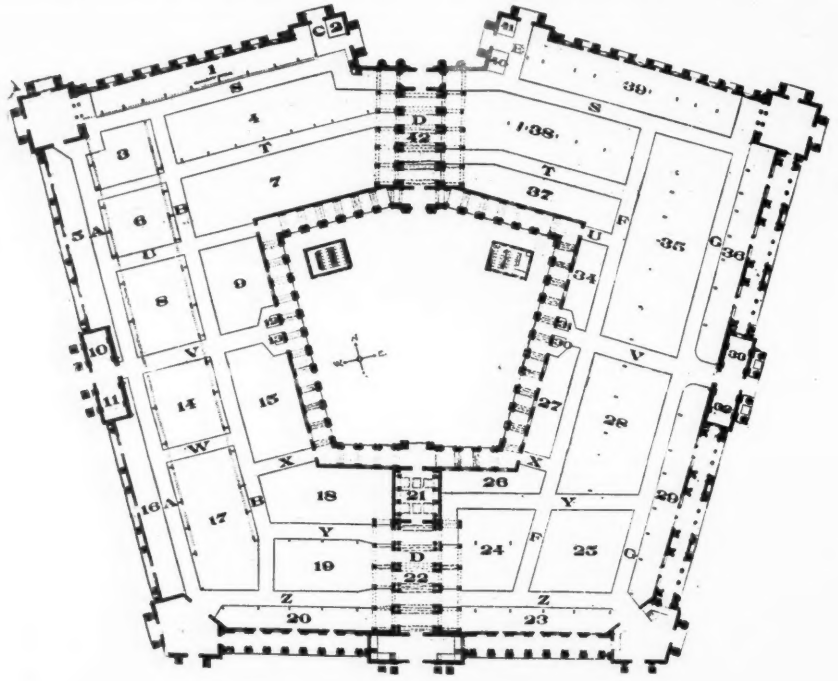
TWO FAÇADES OF THE PALACE OF ELECTRICITY.



PALACE OF ELECTRICITY ON LEFT AND BRIDGE LEADING TO PALACE OF EDUCATION, OPPOSITE, ON RIGHT—NIGHT SCENE, SHOWING BRILLIANT ILLUMINATION WITH INCANDESCENT LAMPS.

lighting and power facilities outside of the exhibit palaces, will be supplied by the power plant, and much of the exhibit apparatus will be utilized to generate this power. In this connection, it may be noted that steam engine units of various types, from manufacturers situated in widely separated parts of the world, are connected to electric generating apparatus built by manufacturers equally foreign to one another.

The lighting features of the exposition, to accomplish which the flexibility of electrical systems of distribution has been taken advantage of in a remarkable manner, are more extensive than could possibly have been dreamed of but a short time ago. In every conceivable manner, electricity enters into the general illumination scheme. Arc lamps, incandescent lamps of many colors, and both clear and frosted globes are used in profusion. The night scene is not comparable with anything which has been witnessed before. The Machinery Hall alone is illuminated by 20,000 electric lamps. On the Varied Industries Building there are 17,000 lamps, and on the Transportation Building, 10,000. The effect is such as to make the colonnades, the columnated towers and the mural decorations stand in blazing relief against the more solid architecture. The interior illumination, which will be mostly by arc lamps, has been worked up with the view in mind of securing just that quantity of light which will render the frescoing and spectacular features most attractive. While this effect has been sought after in the emplacement of the lights, there will be no sacrifice of general illumination for the lighting up of the exhibits.

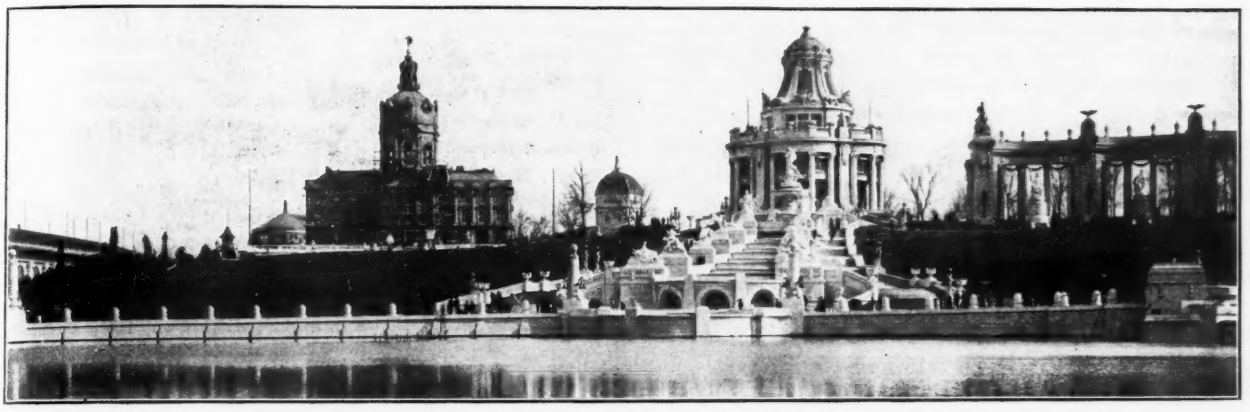


GROUND PLAN OF ELECTRICAL BUILDING.

Following is a partial list of exhibitors in the Palace of Electricity:

Adams-Bagnall Electric Co., Cleveland, Ohio.
A. S. Aloe, St. Louis, Mo.
American Carbon and Battery Co., St. Louis, Mo.
American Circular Loom Co., Chelsea, Mass.
American Electric Fuse Co., Chicago, Ill.
American Electrical Heater Co., Detroit, Mich.
American Electrical Novelty and Manufacturing Co., New York city, N. Y.
American School of Correspondence, Chicago, Ill.
American Telephone and Telegraph Co., Boston, Mass.
The American Watchman's Time Detector Co., New York city, N. Y.
American Watchman's Time Detector Co., Cleveland, Ohio.
Bion J. Arnold, Chicago, Ill.
Association of Edison Illuminating Companies, Chicago, Ill.
Martin Armstrong, St. Louis, Mo.
Atlanta Utility Works, East Point, Ga.
The Automatic Electric Co., Chicago, Ill.
Automatic Fire Alarm Co., New York city, N. Y.
Baird Manufacturing Co., Chicago, Ill.
Carl Bajohr, St. Louis, Mo.
Barion Vacuum Co., New York city, N. Y.
M. V. Barlow, Chicago, Ill.
Mrs. Alexander Baumgart, New York city, N. Y.
Benjamin Electric Manufacturing Co., Chicago, Ill.
The Bristol Co., Waterbury, Ct.
The Browning Co., Milwaukee, Wis.
The Bryant Electric Co., Bridgeport, Ct.
Bullock Electric Manufacturing Co., Cincinnati, Ohio.
Burdette-Rowntree Manufacturing Co., Chicago, Ill.
Burnham, Williams & Co., Philadelphia, Pa.
H. B. Camp Co., Chicago, Ill.
Carbondale Machine Co., Carbondale, Pa.
Carman Projector and Specialty Co., Chicago, Ill.
Central Telephone and Electric Co., St. Louis, Mo.
Chicago Fuse Wire and Manufacturing Co., Chicago, Ill.
Chicago X-Ray Co., Chicago, Ill.
Jas. Clark, Jr., & Co., Louisville, Ky.
A. Frederick Collins, New York city, N. Y.
Commercial Electric Co., Indianapolis, Ind.
Controller Co. of America, St. Louis, Mo.
Cooper Hewitt Electric Co., New York city, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
The Dayton Autoelectric Co., New York city, N. Y.
De Forest Wireless Telegraph Co., New York city, N. Y.
Patrick B. Delany, South Orange, N. J.
The Dayton Electrical Manufacturing Co., Dayton, Ohio.
Dicke Tool Co., Downers Grove, Ill.
Dodd & Struthers, Des Moines, Iowa.
S. R. Dresser, Bradford, Pa.
Economical Electric Lamp Co., New York city, N. Y.
Thomas A. Edison, Orange, N. J.
Electra Water Purifying Co., St. Louis, Mo.
Electric Calculator Co., Chicago, Ill.
Electric Contract Co., New York city, N. Y.
Electric Controller and Supply Co., Cleveland, Ohio.
Electric Railway Equipment Co., Cincinnati, Ohio.
Electric Storage Battery Co., Philadelphia, Pa.
Eureka Tempered Copper Works, North East, Pa.
Faller Automatic Telephone Exchange Co., New York city, N. Y.
Federal Electric Co., Chicago, Ill.
C. J. Field, New York city, N. Y.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
The Gardner Electric Drill and Machinery Co., Cleveland, Ohio.
General Electric Co., Schenectady, N. Y.
Gervais Manufacturing Co., Edgewater, N. J.
G. M. Gest, Cincinnati, Ohio.
W. E. Goldsborough, La Fayette, Ind.
Gould Coupler Co., New York city, N. Y.
Gould Storage Battery Co., Depew, N. Y.
Gray National Telautograph Co., New York city, N. Y.
Gray Telephone Pay Station Co., Hartford, Ct.
A. Grothwell, San Francisco, Cal.
C. F. Hall, Chicago, Ill.
Roberty E. Hayward, Kansas City, Mo.
The Heinze Electric Co., Lowell, Mass.
Hellens, Enke & V. Ludvigsen, Copenhagen, Denmark.
Hinton & Tarkington, Hot Springs, Ark.
Holmes, Booth & Haydens Co., New York city, N. Y.
Holophane Glass Co., New York city, N. Y.
C. W. Hunt, West New Brighton, N. Y.
Hutchison Accoustic Co., New York city, N. Y.
Indiana Novelty Co., Muncie, Ind.
International Acheson Graphite Co., Niagara Falls, N. Y.
J. Van Inwagen, Momence, Ill.
The Jackson Electric Drill and Supply Co., Denver, Col.
The Jandus Electric Co., Cleveland, Ohio.
Charles Kaestner & Co., Chicago, Ill.
Kellogg Switchboard and Supply Co., Chicago, Ill.
Kester Electrical Manufacturing Co., Chicago, Ill.
Keystone Electrical Instrument Co., Philadelphia, Pa.
The Kny-Scherer Co., New York city, N. Y.
D. A. Kusel Telephone and Electric Manufacturing Co., St. Louis, Mo.
The Leclanche Battery Co., New York city, N. Y.
Lincoln Electric Co., Cleveland, Ohio.
Lionel Manufacturing Co., New York city, N. Y.
Lunkenheimer Co., Cincinnati, Ohio.

Locke Insulator Manufacturing Co., Victor, N. Y.
McRoy Clay Works, Chicago, Ill.
Marshall-Sanders Co., Boston, Mass.
W. E. Matthews & Bro., St. Louis, Mo.
The Miller Anchor Co., Norwalk, Ohio.
Moloney Electric Co., St. Louis, Mo.
National Carbon Co., Cleveland, Ohio.
S. W. Stratton, Washington, D. C.
National Battery Co., New York city, N. Y.
National Cash Register Co., Dayton, Ohio.
National Electric Co., Milwaukee, Wis.
Nernst Lamp Co., Pittsburg, Pa.
The Robbins & Myers Co., Springfield, Ohio.
Chicago Rœntgen X-Ray Laboratory, Chicago, Ill.
Roth Brothers & Co., Inc., Chicago, Ill.
St. Louis Brass Manufacturing Co., St. Louis, Mo.
The Safety Insulated Wire and Cable Co., New York city, N. Y.
Sawyer-Man Electric Co., New York city, N. Y.
W. Scheidel & Co., Chicago, Ill.
M. Scherer, Akron, Ohio.
Warren Electric and Specialty Co., Warren, Ohio.
Warren Electric Manufacturing Co., Sandusky, Ohio.
B. F. Wasson, Clinton, Ill.
Western Electric Co., Chicago, Ill.
Wesco Supply Co., St. Louis, Mo.
Western Union Telegraph Co., St. Louis, Mo.
Weston Electrical Instrument Co., Newark, N. J.
Westinghouse Electric and Manufacturing Co., Pittsburg, Pa.



WING OF THE CASCADES, IN CENTRE, WHERE COLORED LIGHTS ARE THROWN UPON AND THROUGH THE WATER; GERMAN BUILDING, ON LEFT; COLONNADE OF STATES, ON RIGHT.

Northern Electrical Manufacturing Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Nungesser Electric Battery Co., Cleveland, Ohio.
The Organ Power Co., Hartford, Ct.
Pawling & Harnischfeger, Milwaukee, Wis.
The Peerless Electric Co., Warren, Ohio.
Perkins Electric Switch Manufacturing Co., Bridgeport, Ct.
The Phelps Co., Detroit, Mich.
Walter P. Phillips, Bridgeport, Ct.
Shedd Electric and Manufacturing Co., New York city, N. Y.
Standard Underground Cable Co., Pittsburg, Pa.
Standard Water Purifying Co., Cleveland, Ohio.
Sterling Electric Co., New York city, N. Y.
Sterling Electric Motor Co., Dayton, Ohio.
William F. Stilz & Co., Philadelphia, Pa.
Sumter Telephone Manufacturing Co., Sumter, S. C.
Telephone Hygienic Co., Los Angeles, Cal.
Wheel Truing Brake Shoe Co., Detroit, Mich.
Wireless Railway Co., Philadelphia, Pa.
The Wyckoff Pipe and Creosoting Co., Stamford, Ct.
Charles E. Yetman, New York city, N. Y.
National Clock Works, St. Louis, Mo.
The Colonial Sign Co., Akron, Ohio.
U. S. Incandescent Lamp Co., St. Louis, Mo.
Westinghouse Traction Brake Co., New York city, N. Y.

LOOKING TOWARD UNITED STATES GOVERNMENT BUILDING, IN CENTRE; PALACE OF LIBERAL ARTS, ON LEFT; PALACE OF MINES AND METALLURGY, ON RIGHT.

Pittsburg Blue Print Co., Pittsburg, Pa.
Pneumatic Signal Co., Rochester, N. Y.
Postal Telegraph Cable Co., St. Louis, Mo.
Printing Telegraph News Co., St. Louis, Mo.
Prometheus Electric Co., New York city, N. Y.
Purdue Research Laboratory, La Fayette, Ind.
Queen & Co., Philadelphia, Pa.
F. Herrero y Ruiz, Albacete, Spain.
Reynolds Electric Flasher Manufacturing Co., Chicago, Ill.
C. J. Toerring Co., Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
Underwriters' Laboratories, Chicago, Ill.
United States Electric Signal Co., West Newton, Mass.
E. C. Van Nort Electric Co., St. Louis, Mo.
Wagner Electric Manufacturing Co., St. Louis, Mo.
R. V. Wagner & Co., Chicago, Ill.
Waite & Bartlett, New York city, N. Y.
Warren Ball-Bearing Fixture Co., New York city, N. Y.
H. E. King, Chicago, Ill.
Cassidy & Son Manufacturing Co., New York city, N. Y.
W. M. Bashlin, Warren, Pa.
Mystic Electric Gas Lighter Co., New York city, N. Y.
C. H. Thordarson, Chicago, Ill.
Dialt Motor Co., Philadelphia, Pa.

The accompanying ground plan of the Palace of Electricity will give some idea of the general layout of the electrical

exhibits. The exhibit space is laid out entirely on the ground floor, which gives a great quantity of head room. In the centre sections of the exhibit palace, the roof is eighty feet above the floor. There is a gallery twenty-two feet wide by 250 feet long over blocks 1 and 2. This gallery is divided up and fitted as offices for the department, jury and committee rooms. Beneath the gallery are the main offices of the telegraph companies. At this point are also located the booths of the technical press. The high-speed telegraph systems of Delany and Phillips are shown adjacent to the offices of the Western Union and Postal Telegraph-Cable companies. A transmitting typewriter applied to telegraph work is exhibited by Charles E. Yetman, and the Gray telautograph is also shown in this department. Block No. 4 is occupied mainly by an exhibit of electrotherapeutic apparatus. The substation containing the transformers, switchboards and rotary converters, through which the high-potential alternating current is received from the service power station and transformed to a lower voltage or converted into direct current for distribution throughout the building, is situated near the centre of block No. 4. The machinery in this section has been furnished largely by the General Electric and Westinghouse companies. The Westinghouse company has one of the largest exhibits in the building, embracing various types of electrical machinery and apparatus, adjoining this station. Electric railway trucks and locomotives manufactured by Burnham, Williams & Company are just across aisle B, and along the north side of block 3 the Standard Underground Cable Company has installed a model conduit system. Running from the floor to the roof above block 3 is an automatic push-button electric elevator manufactured by the Burdett-Rowntree Company. Pawling & Harnischfeger Company has installed a thirty-ton electric traveling crane, driven by a twenty-horse-power, 220-volt motor, the craneway extending over blocks 3 to 17, along the west side of the building.

The Westinghouse single-phase system and the electric air-brake apparatus of the National Electric Company are in the northwest quarter of the building. The Fort Wayne Electric Works and the Wagner Electric Manufacturing Company both have working exhibits in block 9. The Bullock Electric Manufacturing Company has an exhibit in this quarter, receiving power at 6,600 volts, and transforming to 340 volts, with a rotary converter to supply 500 volts direct current for operating the street railway apparatus.

The Northern Electrical Manufacturing Company, the Western Electric Company, the Wesco Supply Company, the Ewing-Merkle Company, the Warren Electric Manufacturing Company and the Commercial Electric Company all have exhibits in the sections embraced in block 8 to block 14. The Carman Projector and Specialty Company and the Hall Gold and Silverplating Works are also located here.

The Gould Storage Battery and Gould Coupler companies are making an exhibit of motor-generator sets and rotary transformers and battery apparatus. The Japanese electrical exhibit is shown in block 16. The Italian exhibit occupies block 18. The Electric Storage Battery Company shows a model station storage battery plant in a fire and acid-proof enclosure. A map showing the location of between 1,600 and 1,700 plants installed by this company for railway, lighting, telephone and isolated installations is indicated by different colored lamps. The De Forest Wireless Telegraph Company has three seventy-five-foot towers and a sending and receiving station in section 19. The T. E. Clark Wireless Telegraph-Telephone Company also has an exhibit at this place. The American Telephone and Telegraph Company has exchanges in block 17, and connections are made at this point with the local and long-distance lines of the Bell company.

The Kellogg Switchboard and Supply Company gives long-distance service through its connection with the Kinloch system of St. Louis, and has an exhibit in block 24. The Automatic Electric Company and the Faller Automatic Telephone Exchange Company show the details and working of their respective automatic telephone apparatus. Mr. M. R. Hutchinson will give daily exhibitions of his apparatus for enabling deaf persons to be made to hear through his "Acousticon" and "Massacon" apparatus. The Holophane Glass Company and the Weston Electrical Instrument Company also make exhibits.

The General Electric Company has the largest individual exhibit, embracing block 28 and covering a quarter of an acre of floor space. In blocks 26 and 27 are the Edison exhibits, which include the iron-nickel storage battery and a collection of historical apparatus. The Standard Water Purifying Company has a system of purifying water by electricity, which is shown in block 33.

There is about $50,000 worth of instruments for testing electrical apparatus of every kind in the laboratories of the National Bureau of Standards, the exhibit of which covers a space 23 by 200 feet. The foreign electrical exhibit is especially complete, the foremost manufacturers of Great Britain, Germany, France, Spain, Italy, Japan, Denmark and Brazil being represented.

The Hon. David R. Francis is the president of the Louisiana Purchase Exposition. Mr. Isaac S. Taylor is the director of works, and Mr. F. J. Skiff is the director of exhibits. Mr. Thomas M. Moore is the chief of the department of machinery. Professor W. E. Goldsborough is the chief of the department of electricity, Mr. E. B. Ellicott is the constructing engineer, Mr. R. H. Phillips is the civil engineer, Mr. Charles F. Foster is the operating engineer, Mr. P. F. Williams is superintendent of electric lighting, Mr. Cloyd Marshall is superintendent of electrical machinery. Mr. Franz Wells is the technical clerk for the department of electricity, and Mr. P. E. Fansler is chief clerk of the same department.

The Convention of the Iowa Electrical Association.

At the fourth annual convention of the Iowa Electrical Association, which was held at Des Moines, April 20 and 21, the following officers were elected for the ensuing year: president, W. L. Bowers, Davenport; vice-president, Austin Burt, Waterloo; secretary, W. S. Porter, Eldora; treasurer, Rufus E. Lee, Clarinda; executive committee, W. G. Greene, Cedar Rapids; G. S. Carson, Iowa City, and A. W. Zahm, Mason City. After the reading of the secretary and treasurer's report, Mr. Robert Ferris, of Monmouth, Ill., made an address on "Station Accounting," and described the methods in practice at the Monmouth, Ill., and Eldora, Iowa, plants.

On Wednesday afternoon, April 20, in continuance of the discussion on uniform accounting, a paper was read by Mr. Austin Burt, of Waterloo. This was followed by a paper on "The Combustion of Iowa Coal," by Professor George W. Bissell, of Iowa State College. A paper was presented by Mr. Paul E. Bellemy, of Knoxville, on "Scale Incrustation in Steam Boilers from a Chemical Standpoint." A paper entitled "Storage Batteries in Connection with a Central Station," was read by Mr. Edward Reavy, of Davenport, and this was followed by papers entitled "Electric Meters" and "Data on Steam Turbines," by Messrs. George S. Carson, of Iowa City, and J. M. Wilkinson, respectively.

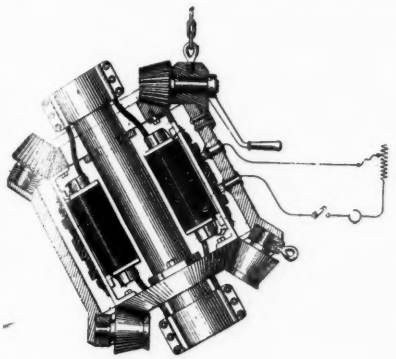
The Thursday morning session was opened by a paper on "Lamp Testing," by Professor L. B. Spinney. Mr. M. A. Harrison, of Osceola, then described a system of series arc street lighting, which was followed by a paper on "Multiple Alternating-Current Arc Lamps for Street Lighting," by Mr. Rufus E. Lee. A short paper was read by Mr. Green, on "Experience with Nernst Lamps," by Mr. G. C. Gardiner, of Mount Vernon.

A short paper was read by Mr. J. A. Innes, of Eagle Grove, on "Renewed Incandescent Lamps." This was followed by papers on "The Best Method of Increasing the Output of Lighting and Power Plants," by A. W. Zahm, and "Operation of Single-Phase Motors on Lighting Circuits," by Mr. W. A. Layman and Mr. Sparrow. This paper was read by Mr. W. O. Thomas.

The next meeting of the association will be held at Dubuque, Iowa, in April, 1905.

Electrical Patents.

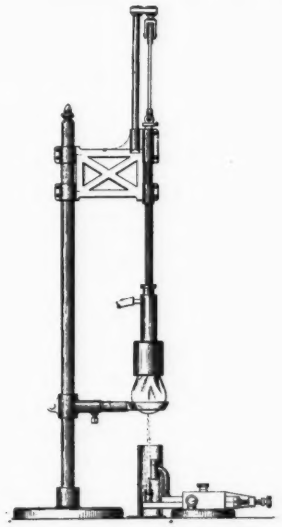
A rotary electric tube furnace has been invented by Henry Noel Potter, of New Rochelle, N. Y., who has assigned the invention to George Westinghouse, of Pittsburg, Pa. The first step in the manufacture of the furnace is to prepare the carbon tube and coat it, preferably with fused magnesia, and then jacket it with calcium oxide and provide circuit ter-



A Rotary Electric Tube Furnace.

minals for the carbon tube. The next and final step is to attach the lining of fused magnesia. This is accomplished by arranging the tube in a cage, so that it will be horizontal. Then by including the carbon tube as a resistance between the terminals of the circuit it is heated hot enough to melt the magnesia, and the tube is then rotated so as to cause the molten magnesia to flow over the inner surface of the carbon tube. In this way when suitable care is taken a dense, even lining of fused magnesia can be spread over the inner surface of the tube, thus supplying a highly refractory surface to the furnace wall. The furnace is so constructed that it may be rotated at any desired angle, as may be required.

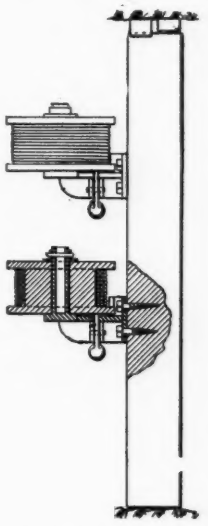
In the manufacture of incandescent electric lamps, the bulb comes from the glass-blower with a single open tubular extension at the stem end, to which the glass pillar which supports the filament is sealed. It becomes necessary to form an opening at some other part of the lamp in order to permit exhaustion of the air, and it is common to form a hole in the centre of the dome to which a small glass tube is fused, this tube being connected with an air pump when the vacuum is made. The hole is formed in various ways, commonly by applying a flame to the point at which it is to be made, and after the glass has been made sufficiently soft the operator blows into the bulb with a quick exhalation, thus swelling the glass around the hole to extreme thinness and bursting it, leaving a ragged edge of the desired size. The object of an invention recently patented by Mr. William R. Burrows, of Newark, N. J., is to accomplish the described result with great uniformity. In carrying out the invention the bulb is mounted in a support and permitting a long slender blow-pipe flame to play vertically at the point where the hole is desired, at the same time placing in communication with the open end of the bulb a mild air pressure, which when the glass reaches the proper stage of softness blows a clean round hole eminently fitted for the connection of an extension tube. The intensity of the flame is such that no ragged edge or fine glass is left as a residue after the operation. This operation is distinctive in character from that of the air pressure applied by the mouth of the operator. The latter is a quick expulsive blast which stretches the glass to extreme thinness before an opening is formed in the bulb; but in the present process the light air pressure applied, about two to four ounces, permits the glass to be punctured by the heat of the flame after being stretched only to a very slight extent, the difference residing in the fact that the



Elevation of Apparatus for Perforating Glass Bulbs.

pressure is light and is applied continuously, and that the flame is continuously playing until the hole is formed, when, of course, the air blast diverts it from the glass. Means for attaching or removing a bell cover or cap through which the air pressure is applied are provided, furnished with a packing at the mouth to effect a substantially air-tight connection.

Mr. William E. Hamilton, of Columbus, Ohio, is the inventor of an electrical wire station. In the embodiment of the invention, a post is employed wedged between the floor and roof of a mine in a position convenient to the machine to be operated. Secured to the post are brackets having spindles on which are spools or reels. These reels are preferably made of wood or other non-conductive material, and on



Electric Wire Station.

these reels is mounted a sufficient amount of copper wire or other conductor to reach from the cross-entry to the face of the room or as far in as necessary to connect with a short insulated cable leading to the machine to be operated. The wire passes through a binding-post by means of which it may be clamped at any desired point. The binding-post is formed so that the wire will be insulated from the iron bracket and make an electrical connection with another short cable, which connects from the binding-post to a terminal post. This terminal post is similar to the binding-post and provides means for connecting the cable to the insulated cable, which connects directly with the machine to be operated. A dog or pawl is pivoted to the bracket and is adapted to engage the lower surface of the reel to prevent the same from unwinding when not desired. The method of installing and operating the apparatus is as follows: the post is rigidly secured in position after which the brackets carrying the spindles are fastened to the post at suitable distance apart, and the reels, one of which contains the wire for the positive and the other the wire for the negative connections, are placed in position. A sufficient amount of wire is then unwound to reach to the main conductors and is connected therewith. The pawl having been depressed to allow the unwinding is released to prevent further unwinding and the binding-post is securely clamped on tne wire.

Reviews of Current Engineering and Scientific Literature.

Lighting Gas Lamps at a Distance.

An ingenious system of controlling gas lamps from a distance has been devised by Herr Frederick Siemens, of Dresden, Germany. The burner is operated by compressed air, which opens or closes a mercury valve. Gas is led into the centre of this valve and discharged in an inverted bell. This is enclosed within a second inverted bell, from which the supply passes to the burner. The bottom of the chamber contains a quantity of mercury, which normally does not come in contact with the bells. To a third chamber, surrounding the one just mentioned, compressed air is led. When air is admitted into this, it pushes the mercury up and closes the mouth of the bells. A by-pass feeds a small jet within the burner, which burns constantly, and which ignites the main flame when gas is turned on. The compressed air is supplied from the controlling station, and is carried to the burners in small pipes. The controlling valve is small, being about three inches high and two inches in diameter.—*Translated and abstracted from the Revue de l'Electricité (Lausanné), April* 15.

Small Gas Engines Compared with Electric Motors.

In view of the increasing use of small gas engines, and the claims of great economy made for them, it seemed to Mr. H. E. M. Kensit desirable that a comparison should be made between this method of driving small factories and the use of electric motors. It is found that the greater number of these gas engines run under very intermittent, irregular loads, and it is especially in such cases that large economies can be secured by substituting an electric motor, both on account of the high efficiency of the latter machine at small loads, and the ease with which it may be stopped and started. The greatest cause of expense of the gas engine is that it must be kept running continuously on intermittent loads, on account of the time and trouble required to restart it. A table is given, showing the actual performance of small gas engines in eight classes of work. These include a bakery, a clothing factory, a joiner-shop, etc. The largest gas engine is rated at thirty-three horsepower, operating a clothing factory. The load-factor in this case was forty-four per cent, and at the current rates for gas and electric power, there is practically no difference between the cost of the two systems. In all other cases, however, where the motors are smaller, there is a decided saving, amounting, in one case, to fifty-two per cent of the cost of the power. It was also found that the gas engine not only costs considerably more to install, but allowance for depreciation and repairs, oil, water and attendance is considerable more than for the motor.—*Abstracted from the Electrical Review (London), April* 15.

Influence of Light on the Velocity of the Formation of Storage Battery Plates.

The statement made recently by M. D. Tommasi, that the formation of storage battery plates is affected by light, is here discussed by M. Georges Rosset. Tommasi has found that, under similar conditions, the negative plates are formed more quickly in light than when in darkness, and the reverse is true of the positive plates. This leads to the general statement, that darkness favors the oxidation of lead, while light favors the reduction of lead oxide. This general law is a consequence of the apparent change in the chemical combining weights. It is a result of the principle of action and reaction, and corresponds to an increase in the temperature of the reaction in the endothermic sense, which is a well-known theoretical and long-verified fact. Thus, light, which is a positive outpouring of energy, shifts the combining in the endothermic sense, while the absence of light, or, in other words, darkness, shifts it exothermically. Light, however, does not change the capacity of the plates, since it does not render them more porous and does not influence in any way the nature of the lead itself.—*Translated and abstracted from Centralblatt für Accumulatoren (Gross-Lichterfelde-West), April* 15.

A Normal Standard Cell for Technical Laboratories.

While the Clark cell is fairly satisfactory as a standard for physical laboratories, according to M. Georges Rosset it is not suitable for a technical laboratory, because of its high temperature coefficient, and because it can not deliver any current. For such laboratories a standard Daniell cell is entirely satisfactory, and it may be constructed so as to have a negligible temperature coefficient. Experimental investigations by M. J. Chaudier show the effect upon the voltage and the temperature coefficient of variation in the concentration of zinc sulphate. This coefficient is first negative, then becomes positive, and then again negative. With a concentration of about 7.5 grammes of zinc sulphate in 100 grammes of water, with a copper solution saturated at fifteen degrees centigrade, the temperature coefficient is zero. This condition, however, is not altogether satisfactory for practical working, since very slight changes in the concentration of the zinc sulphate affect the voltage of the cell considerably. Mr. Fleming Jenkin suggests the following method of constructing a standard Daniell cell: electrolytic copper and distilled zinc; the first placed in a copper sulphate solution of specific gravity 1.2 or 1.1; the second in a zinc sulphate solution with a specific gravity of 1.2 or 1.4. The first gives an electromotive force in international volts of 1.099; the other, 1.069. Where saturated solutions are used, care must be taken to prevent errors due to change in concentration, caused by a change in temperature.—*Translated and abstracted from Centralblatt für Accumulatoren (Gross-Lichterfelde-West), April* 15.

Electric Heating Systems.

In the fourth instalment of a series of articles on the heating and ventilation of workshops and factories, by Mr. Ernest G. Beck, the use of the electric systems is discussed. With other heating systems it is impossible to realize the ideal conditions, but with the electrical systems there is no such practical difficulty. The efficiency of the method is nearly 100 per cent, since there is little leakage, and the loss in the conducting mains is usually negligible. The system is economical, since it is easily regulated. Although in point of actual cost of the heating medium, the electrical system, as compared with hot water and steam, is at a disadvantage, the bill for electric heating is often less than that for steam, because electrical energy is supplied by meter, and the consumption varies exactly as the power developed. This more than counteracts the higher cost of the current. Some of the decided advantages of electrical systems, apart from the questions of economy and energy efficiency, are the absence of piping and valves, economy of floor space, the ease with which energy is

delivered to the heater and with which radiators can be moved from one position to another. There is no difficulty in maintaining a circulation of current, as is often the case with hot-water systems. The disadvantages of the electrical system are: care must be taken in installing the wires to see that they are thoroughly insulated, and the radiators themselves must be constructed so as to guard against short-circuits. The actual heating surface must be encased to protect it from accidents. While electric heating systems are not widely used yet, the author believes that they will become very popular in the future. They would seem especially suited for shops which are lighted and operated by electricity.—*Abstracted from the Machinery Market (London), April 7.*

A Process for the Rapid Formation of Lead Storage Batteries.

The advantages of the Planté system of forming storage batteries of the pasted type are, according to M. Léon Lejeune, causing the former to be adopted by storage battery makers in place of the latter, in spite of the longer time required for formation and the expense of this method. The process itself is ideally simple, requiring merely the passage of a current through the solution in which the plates are immersed; but with this simple treatment it is difficult to cause the formation of the peroxide plates to penetrate into the plate, because of the density of this compound. On the other hand, the protoxide is soft and easily penetrated by the electrolyte, and it occurred to the author that, if the formation of the peroxide could be prevented during the electrolytic formation, the oxidation being stopped at the formation of the lower compound, the formation would take place more rapidly and penetrate more deeply into the plate. To accomplish this, some reducing agent is added to the electrolyte. Several such are available, but that seeming to give the best results is glucose, as this does not form precipitates, due to the action of sulphuric acid; it contains nothing which reduces the life of the plates; it does not cause disengagement of the gases, and it is not expensive. The process consists in placing the plates which are to be formed in a three-degree Beaumé solution of sulphuric acid, to which is added a given weight of glucose. This dissolves of itself, without further attention. A current is passed for about 120 hours. The plates are then removed, washed and placed in the usual acid solution, and upon charging for one or two days, are ready to be put into service. This process gives a true Planté formation, and has been patented in a number of countries.—*Translated and abstracted from L'Électricien (Paris), April 16.*

The Measurement of Certain very Short Intervals of Time.

It was discovered by Kerr, that a layer of carbon bisulphide bounded by two metal plates, and thus constituting the dielectric of a condenser, becomes doubly refracting when the condenser is charged. The arrangement for demonstrating this phenomenon consists of two vertical plates about eighteen centimetres long and three centimetres high, with an interval between them of three millimetres. The line of vision is along the length, and horizontal. By means of polarizing and analyzing nicols, a beam of light may be made to disappear and reappear as the condenser is charged or discharged. This suggests the question of what would happen if the light viewed be that of the spark by which the condenser is discharged; a problem which has been investigated by MM. Abraham and Lemoine. The results of their work are here described by Lord Rayleigh, who himself has also studied the phenomenon. In carrying out the investigation, the condenser is charged from a Ruhmkorff coil fed with an alternating current. It is then discharged through a deflagrator, means being provided, such as a blast of air, to secure an intermittent action, not a continuous flow of current. The observations of Abraham and Lemoine bring out the striking fact that, if the course of the light be prolonged with the aid of reflectors, so as to delay by an infinitesimal time its arrival at the carbon bisulphide, the opportunity to pass afforded by the double refraction is, in a great degree, lost. There is here no change in the electrical conditions, but merely a delay in the arrival of the light. Lord Rayleigh's work with this apparatus enabled him to show clearly the increase in the time required for the light to travel a distance of one metre. He has also shown the retardation of the light, caused by passing it through a tube containing carbon bisulphide, the other conditions of the experiment remaining constant.—*Abstracted from Nature (London), April 14.*

Liquid Fuel Burners.

In the first section of a serial article on liquid fuel burners, Mr. J. S. V. Bickford gives the conditions which must prevail in order that a steady flame may result. The usual arrangement first tried by experimenters for obtaining a jet of vapor from oil is a heated coil. If properly designed, this will work, but usually it will be found that the flame pulsates and surges badly. This is due to the oil running forward to the heated part of the tube, where it suddenly vaporizes, producing an increase of pressure which checks the supply of oil. The pressure then falls below the normal, and another rush of oil takes place, resulting in another pulsation. This trouble is checked by having the coil only large enough to vaporize the oil—that is, having only heating surface enough for the production of the necessary amount of vapor; but if the coil is cut down to this extent, the burner is apt to prime oil. If the coil is just hot enough to keep things going, it is apt to get hotter and superheat the vapor, in which case the nipple will not pass the amount of oil required. It is very difficult, if not impossible, to keep the exact dimensions required. Another method of preventing pulsation is to regulate the supply by means of a valve, which is adjusted to pass only the necessary amount of oil. The position of the vaporizer also affects the stability of the flame. If this be inclined downward, so that the oil tends to run forward to the nipple, the flame pulsates wildly. Sloping it the other way, so that vaporization takes place on a rising gradient, does away with this variation. The application of the following rules will cure any case of pulsation: the supply cock must be opened only just enough to supply the necessary oil. The vaporizer must be of considerable diameter compared with its length. It must be inclined upward, at that portion where vaporization takes place. The supply pipe must be covered to prevent its heating. A burner arranged according to these rules would give a steady discharge of vapor, but this vapor will not burn by itself, because, if it is unmixed with air, the flame will travel over the surface more slowly than the jet is discharged. To keep it ignited, a flame must be maintained in contact with the jet. This is usually accomplished by introducing a baffle-plate, which checks the velocity of the outer part of the jet of vapor, so that, at this point, it burns steadily, and this flame keeps the whole jet ignited.—*Abstracted from Engineering (London), April 15.*

A Convention Exhibit.

The McKenney & Waterbury Company, 181 Franklin street, Boston, Mass., has made special arrangements for the reception of visitors during the convention of the National Electric Light Association, May 24-27. The company's large warerooms will be thrown open for inspection. A cordial invitation is extended to every attendant to call and examine the line of goods which will be prominently displayed.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Central Station Specialties.

The Lundin Electric and Machine Company, Incorporated, 176 Federal street, Boston, Mass., is the manufacturer of an extensive line of specialties utilized in central station practice. The accompanying illustrations show two specialties which are meeting with a well-merited popular demand.

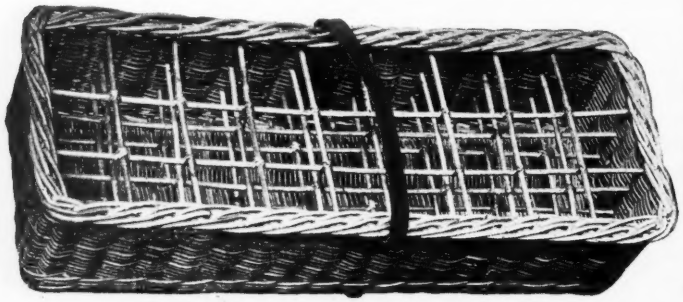


FIG. 1.—TRIMMER'S RATTAN BASKET FOR CARRYING INNER GLOBES.

Fig. 1 shows a trimmer's inner globe basket. This is made of rattan, and is used for carrying inner globes used with enclosed arc lamps. A great deal of the breakage which obtains with inner globes is caused by careless handling. By having a suitable basket to carry inner globes, the breakage is decreased at least fifty per cent. These baskets are made to carry any desired number of globes. The standard size will hold from eighteen to twenty-seven, according to the outside diameter of the globes.

FIG. 2.—HANGER-BOARD WITH CUTOUT FOR SERIES ARC LAMPS. FOR INDOOR USE.

FIG. 3.—HANGER-BOARD WITH HOOD, INSULATED HANGER AND ABSOLUTE CUTOUT FOR SERIES ARC LAMPS. FOR OUTDOOR USE.

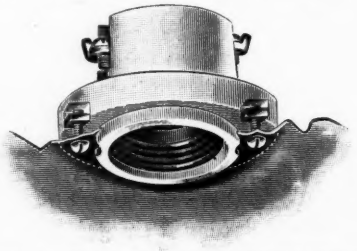
The basket is well made throughout, and is equipped with a strong carrying handle. It is being used by a large number of lighting companies throughout the country, and is receiving very strong commendation.

Fig. 2 shows another specialty which this company is making, in the form of an arc lamp hanger-board with absolute cutout. This is for series, direct or series-alternating arc lamps for indoor or outdoor use.

Fig. 3 shows the cutout equipped with hood and insulated hanger. The hanger-board is made of one solid piece of porcelain, and the working parts are confined in its chamber, protected entirely from dust and dampness. As well as being suitable for any form of circuit, the device will work equally well on either high or low-tension lines. Neither fibre nor mica is used with this cutout, and it has a break of seven-eighths of an inch. When the switch is thrown off, it cuts out the lamp entirely from the live circuit, ensuring safety to the trimmer who handles the lamp.

New Forms of Incandescent Lighting Clusters.

The accompanying illustrations show a new form of incandescent lighting cluster and receptacle placed on the market by the Benjamin Electric Manufacturing Company, Chicago, Ill. These large-sized clusters are made in all sizes for eight, ten and twelve lights, and for fifteen to twenty lights. The latter size of cluster is shown in the accompanying illustration with a large reflector, this being a twenty-light cluster for fifteen lights in the outer circle and five lights in the inner circle.



PORCELAIN REFLECTOR FOR CLUSTER LIGHTING.

The clusters are made up of sheet-metal shell with suitable openings, into which are fixed porcelain receptacles of a special design. This receptacle is shown herewith, and has terminal plates inside of the shell, and the connections are made very easily. By means of this receptacle it is possible to make up a large variety of forms and designs, with any number of lamps.

INCANDESCENT LAMP CLUSTER, WITH REFLECTOR.

The Benjamin company will have a full line of its apparatus on exhibition in section 25 of the Electricity Building, at the St. Louis Exposition.

Recent Installations of Cooper Hewitt Lamps.

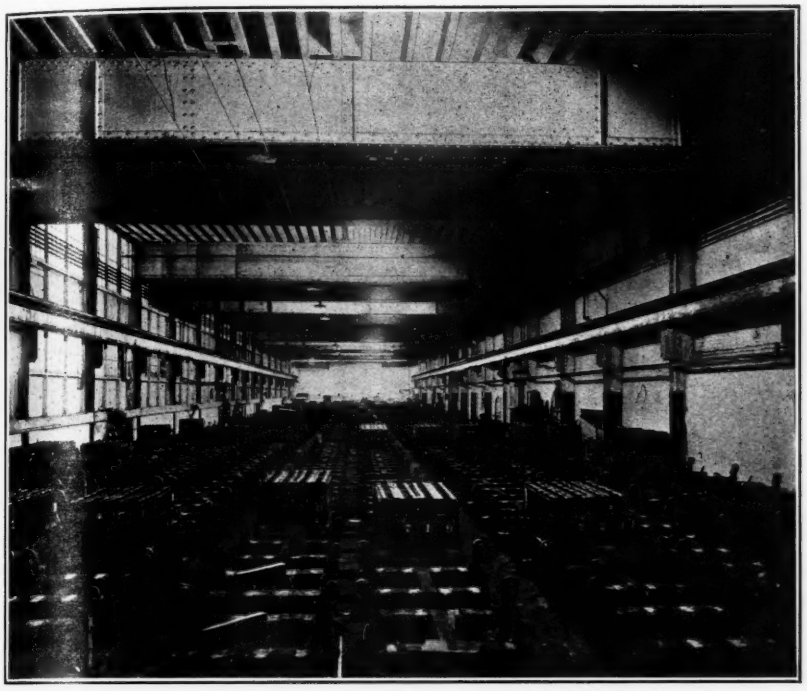
The Cooper Hewitt lamp is finding numerous fields for utilization, in which its peculiar advantages are of considerable importance. One recent instance of this is the installation in the battery room of the New York Transportation Company, Forty-ninth street and Eighth avenue, New York city, of ten three-ampere lamps of the V-5 type. This room was formerly lighted by fourteen five-ampere arc lamps, the entire lighting taking about sixty amperes at 115 volts. The illumination was poor, and the fumes from the batteries interfered considerably with the proper operation of the mechanism of the lamps. It was, in fact, necessary to remove the mechanism from the hood of the lamp and place it under a separate cover. These lamps never gave satisfaction. The ten Cooper Hewitt lamps which have been installed have thus not only reduced the current to one-half of that formerly required, but they have been in operation for the past three months without giving any trouble whatever, running practically twenty-four hours per day. The room, which is 302 feet long, 42 feet wide and 20 feet high, is excellently lighted at all points. The lamps are suspended from the ceiling, and are entirely out of the way of the traveling cranes.

Other recent installations of these lamps

are given in the following table, which shows the character of the work, the current required and the illumination:

Character of Work.	Area of Room.	No. of Lamps.	Current Consumed. Amps.	Volts.	Area Lighted per Lamp.	Area Lighted per Amp.
Draughting room.....	2,140 sq. ft.	8	3.4	110	265 sq. ft.	80 sq. ft.
Business office.....	1,100 " "	3	3.3	110	366 " "	110 " "
Leather factory.....	12,000 " "	30	3.3	55	400 " "	121 " "

It will be noticed that different degrees of illumination are given in the three instances. The amount of light required in a leather factory is, of course, not as great as that which is essential for a draughting room.



BATTERY ROOM ILLUMINATED WITH COOPER HEWITT LAMP.

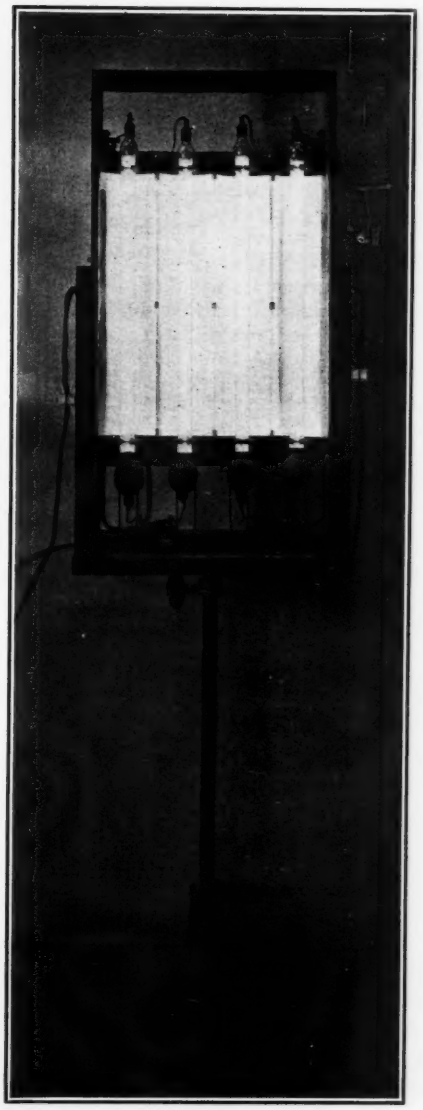
For general illumination, three types of the Cooper Hewitt lamp have been developed. Two of these types—V-5 and H-4—give 700 candle-power. The third type, V-4, gives 300 candle-power. The type V-5 is placed in an inclined position, and starts either by tilting or by the quick-break method. Type H-4 is placed in any position, and is started by the quick-break method. Type V-4 is half the size of the other two, and is suitable for fifty-five volts, two of them being used in series on 110 volts, direct current.

In the lamps just mentioned, both electrodes are formed of mercury. In the newer type of lamp, iron is substituted for one of the mercury electrodes, which allows the lamp to be placed in any position. This construction allows many convenient arrangements of the lamp to be made, and it appears to increase their life. The lamps are arranged with enameled reflectors, and generally start by the tilting method, as this is cheaper and more convenient than the quick-break method. This type lends itself readily to combinations for photographic and photo-engraving work, and many are being used successfully for this purpose. They are also excellent for enlarging and reducing, and a combination for this class of work is shown in the accompanying illustration. This consists of four H-6 300-candle-power tubes arranged vertically in a frame, which allows them to be tilted for starting. For enlarging, these lamps

NEW FORM OF COOPER HEWITT LAMP FOR GENERAL ILLUMINATION.

are placed behind an opal or ground-glass screen, which is thus uniformly illuminated. In photo-engraving the lamp is particularly good, for the light is not only highly actinic—which reduces the time necessary for exposure—but the negative is heated less with the Cooper Hewitt lamp than with the old combination of arc lamp and condenser, and it is no longer necessary to stop the operation in order to allow the negative to cool.

Other installations of these lamps which have been arranged for are as follows: James A. Hearn & Son, New York city, is installing fourteen in its shipping and packing department. The Westinghouse Electric and Manufacturing Company's exhibit at the World's Fair will be lighted with Cooper Hewitt lamps—ten of the H-6 and ten of the V-5 having been installed. The Sanders Engraving Company's exhibit will contain several of these engraving and printing outfits, and the Salvation Army will exhibit a large number of transparencies prepared and illuminated by the Cooper Hewitt lamp.



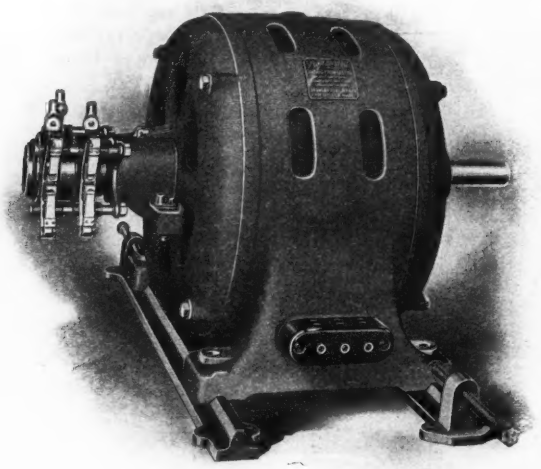
NEW FORM OF COOPER HEWITT LAMP FOR PHOTO-ENGRAVERS.

These lamps are being manufactured by the Cooper Hewitt Electric Company, 220 West Twenty-ninth street, New York city.

Variable-Speed Induction Motors.

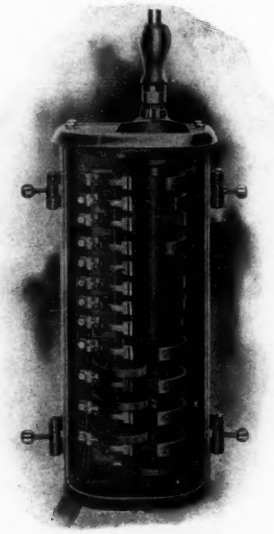
By reason of its excellent service under varying conditions, the direct-current motor of both the shunt and series, as well as the compound type, has won a reputation such that many engineers are loath to make use of alternating currents, unless there exists some particularly strong reason for such a change. This being the case, for some time the direct-current motor has held the field against all forms of alternating-current apparatus, and the designer of a machine of the latter type has had more than ordinary difficulties to surmount in inducing a faith in the practicability and value of these machines.

Whether for multiphase or single-phase circuits, the induction motor, as built to-day, has a strong point in its favor in the speed regulation which may be obtained, on account of its tendency always to run at practically a constant speed. Operating without load, the motor runs at what is called a synchronous speed, this being determined by the frequency of the circuit from which the current is supplied. There may be a drop of a few per cent at full load, but for many classes of service this is negligible. The induction motor is not inherently adapted for variable-speed control, but the difficulties existing in this direction have been overcome, and it is possible to adapt the induction motor to service where variable speeds are necessary.

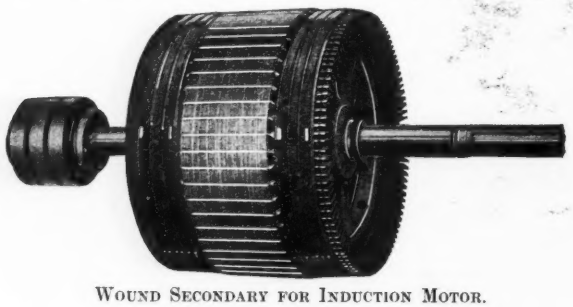


THREE-PHASE INDUCTION MOTOR, WITH RESISTANCE IN THE SECONDARY.

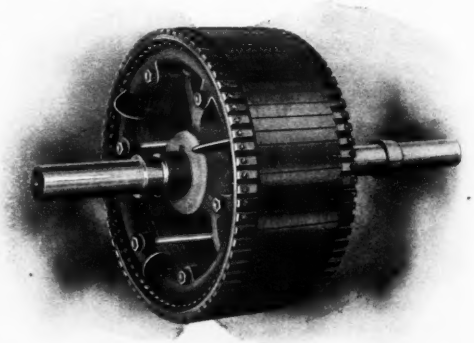
Special attention is being given this motor by the Stanley Electric Manufacturing Company, Pittsfield, Mass., and four general methods for varying the speed of the multiphase induction motor are being developed: first, by inserting a resistance in the secondary circuit; second, by varying the voltage on the primary circuit of the motor with a high-resistance secondary; third, by changing the frequency of the circuit from which current for the motor is supplied; fourth, by changing the number of poles in the winding. The first method is that which is most commonly used. Ordinarily the secondary circuit is the revolving part and has a three-phase winding with three collector rings, so that resistance may be connected to these rings for varying the speed. Generally there are three branches to this resistance, with star connection, and a controller is used for short-circuiting connections of the resistance. This is equivalent to moving the neutral point gradually up to the ends connected with collector rings. When these three ends are short-circuited, the motor acts similarly to an ordinary motor with short-circuited low-resistance secondary winding. With this arrangement a complete controller speed can be obtained, the regulation depending entirely upon how expensive and complicated it is best to make the controller and resistance. It is possible to obtain any speed from zero up to full speed, at any value of torque which the motor is capable of developing, from zero up to its maximum. The chief disadvantage of this method of speed control is the low efficiency obtained if it is necessary to develop large torque at low speeds. The use of this method, therefore, is generally confined to those cases where efficiency is



CONTROLLER FOR OPERATING INDUCTION MOTOR AT VARIABLE SPEED.



WOUND SECONDARY FOR INDUCTION MOTOR.



SQUIRREL CAGE SECONDARY FOR INDUCTION MOTOR.

not of great importance, or where the motor runs at low speed only a comparatively small portion of the time.

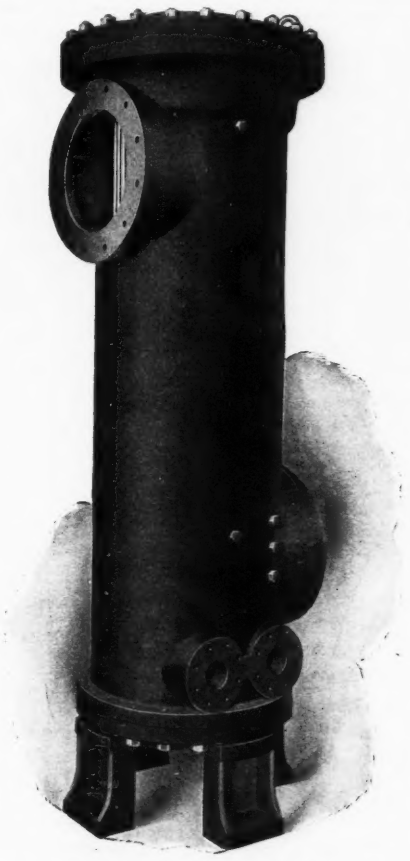
The method of speed control by means of varying the resistance in the secondary circuit deprives the induction motor, to a certain extent, of one of its strong points, which is simplicity of construction. On this account, the second method—that of varying the potential on the primary—has its advantages, for it makes it possible to use a squirrel-cage armature. The armature winding in this method of speed control is usually made of a high-resistance material, so as to give a large starting torque and considerable slip at full load and normal voltage. The voltage on the motor is then varied, with a resulting variation in slip, so that nearly as wide variation in speed and in torque can be obtained as in the method of speed control by varying the secondary resistance. The voltage on the primary may be varied by inserting or cutting out resistance.

The third method of speed control—that of changing the frequency of the circuit from which the motor is run—makes possible a low-resistance armature, and the variations in speed due to change in load are practically nothing. The efficiency is high at all speeds, and the squirrel-cage armature can be used without difficulty. The different frequencies are usually obtained by means of several sets of wires and generators arranged to give several different frequencies. Two additional wires are generally used on multiphase systems for each additional frequency; a common-return wire being used for all frequencies. This method is being used to some extent in machine shops, with good results. However, only a small number of changes of speed can be obtained.

The fourth method of speed variation—by changing the number of poles in the motor—accomplishes practically the same results as changing the frequency, without the necessity of having more than one frequency from the generator. One method of accomplishing this is to place two or more entirely separated primary windings in the slots of the motor, each having a different number of poles and separate terminals to which the supply circuit may be connected. Another method is to use a special scheme of connecting a single primary winding so that two or three different numbers of poles may be obtained by a change in the connections of the motor terminals. The squirrel-cage armature is necessary with this method of control, since the number of poles in which the armature is divided does not depend upon its winding, but upon the number of poles in the field in which it is placed.

A Multi-Current Feed-Water Heater.

The Blake-Knowles multi-current feed-water heater, shown in the accompanying illustration, is manufactured by the Blake & Knowles Steam Pump Works, 114 Liberty street, New York city. This heater is so designed that the feed water makes several turns, keeping it in motion at a certain speed. The tubes are of the size best suited to allow the entire body of water to absorb the heat thoroughly. The tubes are easily accessible for cleaning and special care has been taken to



MULTI-CURRENT FEED-WATER HEATER.

care for the expansion and contraction, making it possible to use copper or brass, as occasion requires. The ends of the tubes are firmly expanded and secured in the tube heads, one of which is rigid and part of the main shell casting. The other head is bolted to a steel plate or diaphragm, the periphery of which is attached to the flange of the heater shell. This arrangement takes care of the unequal expansion between the tubes and the shell, and is reliable and free from strain under all conditions of temperature and pressure.

The tubes are arranged in six nests, and the flow of water through them is controlled by the partition in the water chambers at each end of the heater, so that the water will pass through each nest in turn, thus traversing the heater six times. The circulation is positive, and the heater is designed to give an even distribution of water, avoiding a sluggish flow or positive stagnation.

The operation is simple. The exhaust steam from the engine is thoroughly and evenly distributed by means of partitions in the heater shell, and the flow is so diverted as to pass three times through the heater and circulate freely among the tubes. The total absence of stuffing boxes and packings of any kind in this heater does away entirely with the possibility of leakage and loss of feed water.

The cross-sectional area between the tubes is greater than the area of the exhaust water, offering no obstruction to the flow of the steam, and thus eliminating back pressure. Entrained water is removed by drip pipes.

Access to the heater is had by removing the heads. The tubes of the vertical heaters can be cleaned from the top, and the horizontal heaters from either end. Feet or saddles are furnished, as occasion requires. Mud blocks are provided to keep the heater clean and free from sediment. Every heater is tested under 250 pounds pressure per square inch, giving a safe working pressure of 175 pounds. The heaters are made in sizes up to 5,000 horse-power, in both horizontal and vertical types.

Parsons Single Jet Disc Turbine.

It has been found that, where turbine blades are employed at the periphery of a disc of considerable diameter, the skin of the friction disc supporting the blades and rotating in the exhaust of the medium operating a turbine of any area is a large source of loss in the utilization of the energy of the operating fluids. To reduce the loss, Mr. C. A. Parsons has patented an arrangement of turbine which screens the disc and the blades, when they are inoperative, from the atmosphere and the operating fluid. The containing-case is made steam-tight by close fitting and by means of baffle-plates, and is connected to the condenser vacuum chamber. The steam jet or jets strike the blades at but a few points, and the exhaust steam passes out through a specially arranged exhaust chamber. When the turbine is to be reversible, the reversing blades are also placed so as to rotate idly within the vacuum chamber case, in which the pressure of the steam is less than that in the exhaust chamber, and a nozzle is placed, which may direct a jet of steam against them for driving the machine in the opposite direction. The turbine shaft is provided with thrust collars to prevent axial movement.

1,500-Kilowatt Alternator for St. Louis Exposition.

The National Electric Company, Milwaukee, Wis., has installed at the central power station at St. Louis a National alternating-current generator, direct-connected to a 2,250-horse-power Hamilton-Corliss vertical cross-compound engine. The rated output is 1,500 kilowatts, twenty-five cycles, 6,600 volts, running at eighty-three revolutions per minute. The power generated will be used for various purposes.

The alternator is on the standard lines of the National Electric Company, and is of the revolving-field type, leaving the armature stationary and easily accessible. The difficulty of properly insulating the armature coils is eliminated, as the windings are not subject to any mechanical strains whatever. The revolving field is of large diameter, giving additional flywheel effect to the engine, and the construction of the field coils is such as to render them particularly safe from injury. All parts are accessible, and the method of ventilation, the manufacturer states, ensures low temperatures.

The revolving field is made of cast steel, in halves. These are bolted and secured together by shrunk links. The rim of the wheel is in channel cross-section, to which cast-steel pole-pieces are bolted. The field coils comprise sixty-five turns of one and one-half by one-eighth inch copper strap, wound on edge and thoroughly insulated, the outer edge of the coil being exposed to the atmosphere for cooling. Laminated pole-shoes are secured to the ends of the pole-pieces, and serve to hold the field coils in position. These shoes cover a large polar arc, distributing the magnetic flux evenly. The field coils are insulated from the pole-pieces by fullerboard, and from the pole-shoes and spider ring by heavy fibre. The revolving field is sixteen feet in diameter and weighs approximately 50,000 pounds.

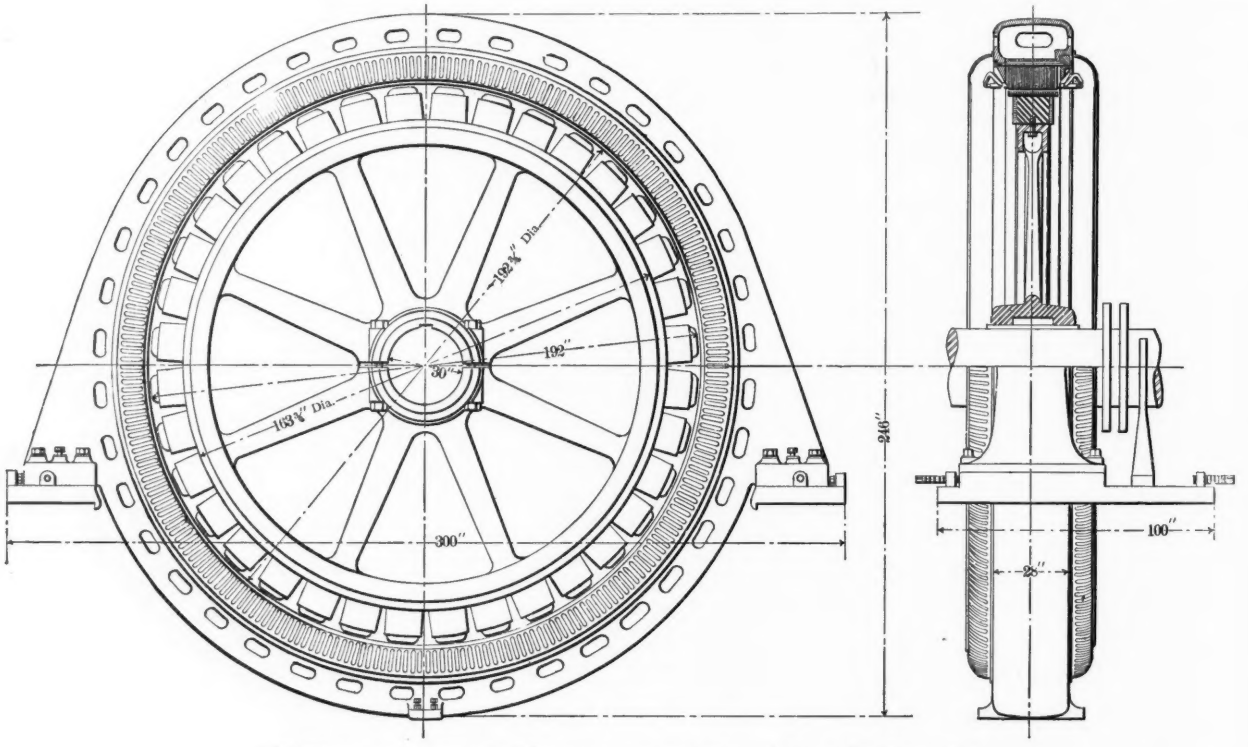
The frame is a circular cast-iron housing, in which laminated punchings with inwardly projecting teeth are assembled for the reception of the armature windings. The frame is extremely heavy and stiff, and does not require any external support. It is divided horizontally, the halves being firmly bolted and keyed together. Bolts and keys are contained entirely within the cross-section, obviating the use of side lugs. As may be seen from the diagram herewith, large open spaces are provided in the sides of the frames, allowing a free passage of air from the ventilating ducts in the core.

The armature core is built up of laminated soft steel punchings, annealed and japanned before assembling. Ventilating space blocks are inserted at suitable intervals, providing openings extending around the circumference, and allowing a free passage for the heat generated in the windings. There are six slots per pole, two and one-half inches deep and one and one-half inches wide, each being wound with fourteen conductors 0.37 by 0.28 inch compressed copper strand. The internal diameter of the armature is sixteen feet three-quarters inch, and the width of the core is sixteen inches.

Cast-iron collector rings and carbon brushes are used, enabling the machine to be operated with a minimum amount of attention, and at the same time providing a collector gear which will carry a heavy temporary overload.

The net weight of this alternator is 135,000 pounds, and the following are the guarantees which the National Electric Company offers on this machine: efficiency, one and one-quarter load, 95.5; full load, 95.5; one-half load, 94.75; regulation, 5.5 per cent on power-factor one; twenty-two per cent on power-factor 0. The temperature rise will not exceed thirty degrees on armature and magnets on a continuous run at full load, and forty degrees on the armature and magnets on a continuous run at twenty-five per cent overload.

The National Electric Company, which is the successor to the Christensen Engineering Company, although only entering the electric field about two years ago, is constantly increasing its business and witnessing a steady demand for its direct and alternating-current apparatus.



1,500-Kilowatt Alternator Installed at the World's Fair, St. Louis, Mo.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

TELEPHONE SYSTEM FOR LIMA, PERU—It is stated that the American Bell Telephone Company will install a complete telephone system in Lima, the capital of the republic of Peru, South America. In addition to the installation at Lima, there may be exchanges established in several other Peruvian cities, the service to be under government control.

NEW YORK CENTRAL FILES PLANS FOR ITS POWER-HOUSE—The New York Central & Hudson River Railroad Company has filed in the Bronx building bureau of plans its specifications for one of its large power-houses to operate trains in and out of the Grand Central station. The site selected is on the south side of 149th street, ninety-five feet from Long Island sound. It will be a three-story brick structure, the ground plan being 236.6 by 156.4 feet. The estimated cost of the foundations alone is placed at $75,000.

NEW CHICAGO (ILL.) RAILROAD COMPANY CHARTERED—The Chicago & Oak Park Railway Company, with a capital of $9,200,000, of which $6,000,000 is common and $3,200,000 preferred stock, was incorporated at Trenton, N. J., on April 23. The registered office of the company is in Jersey City. The company is chartered to take over the properties and franchise of the Chicago & Oak Park Railway Company, and the incorporators are Charles D. Boston, West Orange, N. J.; William R. Stainsbury, Bath Beach, N. Y., and John C. Quimby, Bronxville, N. Y.

NEW COLORADO ELECTRIC ROAD INCORPORATED—An electric railway connecting Denver with Fort Collins, Loveland, Berthoud and all the northeastern towns of the state of Colorado, is soon to be constructed by the Northern Colorado Electric Railway Company. The principal offices of the company will be at Fort Collins, and the main line of the railroad will run from Fort Collins to Denver, *via* Loveland, Berthoud, Johnstown, Longmont, Boulder, Erie, Louisville, Lafayette and Golden. This will take in the sugar beet belt, with the branch lines which are to be run to Eaton and Greeley, and by Chambers Lake to Grand County. The capitalization of the company is $1,000,000, divided into 100,000 shares of the par value of $10 each. The directors are Peter J. McHugh, L. C. Moore, Robert L. McCullough, Robert A. Edmonds and William O. Mosman.

MEXICAN ELECTRICAL NOTES—Zacatlan, a city of some 2,500 people, located in the state of Puebla, Mexico, is to have a municipal electric light and power system. Plans have already been drawn up by the city council for submission to the state department for approval. The Campania Maustral de Guadalajara, which operates a 2,000-horse-power hydraulic plant at Las Juntas, for the purpose of transmitting current to Guadalajara for lighting purposes chiefly, is about to let contracts for 2,000-horse-power additional equipment. The canal and tunnel for the Atlixco Light and Power Company, of Puebla, Mexico, have been completed by the contractors, Hill Brothers, of Puebla, and the work of constructing the pipe line has been commenced. The canal is 990 feet long, and the tunnel is 3,135 feet long. The pipe line will lead from the mouth of the tunnel, and will be 2,970 feet long, and will have a drop of 135 feet. The water supply thus obtained will generate 750 horse-power. The cost of these improvements will be $150,000.

ENLARGEMENT OF THE CENTRAL NEW YORK TELEPHONE COMPANY—The sum of $1,000,000 has been appropriated by the management of the Central New York Telephone and Telegraph Company and the Empire State Telephone and Telegraph Company to improve and extend these systems. About half this sum will be expended in Syracuse in the immediate future, $350,000 of it in a new five-story fireproof telephone building in Montgomery street and its equipment, and the balance in betterments of the system in the addition of new switchboards and extending the underground conduits. The telephone company has bought the lot fronting sixty-six feet on Montgomery street, with a depth of 132 feet, immediately south of the Mason Building, which was recently acquired by the company. The new building will be erected on this lot. The Mason Building, recently purchased by the company, and the present telephone building north of it will be disposed of later. The new apparatus will be of the very latest type and have a capacity for 20,000 stations, that is telephones. In addition, a large outlay will be required to take care of the increasing toll business which must have its independent facilities in the way of new switchboards. There will be a new thirty-position toll-board. The underground conduit system will be very largely extended in order to avoid the multiplicity of wires and cables which the business of the company requires.

CENTRAL OHIO TRACTION DEAL—Announcement is made by A. E. Appleyard & Company of their plan for taking over the traction roads of central Ohio under the charter of the Ohio Union Traction Company, incorporated at Columbus several weeks ago. It is stated that the total bond issue, including the underlying issues, will not exceed $30,000 per mile of single track, and $10,000 additional per mile of double track of main line, exclusive of turnouts and sidings, outside of cities, and $60,000 per mile of single track and $40,000 additional per mile of double track of main line within cities, except where those are situated upon unpaved streets the limitation shall be $5,000 per mile. Holders of stocks or bonds of the Dayton, Springfield & Urbana line; Columbus, London & Springfield; Columbus, Grove City & Southwestern; Central Market; Urbana, Bellefontaine & Northern; Kenton & Southern; Springfield & Western, were given until May 1 to exchange their five per cent bonds in $1,000 blocks for the Ohio Union Traction Company's first consolidated mortgage fives, based on their respective marked values as follows: D., S. & U. bonds, 110; Grove City bonds, 105; Central Market bonds, 107; Urbana, Bellefontaine & Northern bonds, 105; Kenton & Southern bonds, 100; Springfield & Western bonds, 105; Central Market, preferred stock, 100; Central Market, common, 30; D., S. & U., preferred, 95; C., L. & S., common, 50; C., L. & S., preferred, 70. In all there will be 100 per cent bonus of common stock of the Ohio Union Traction. One hundred dollar receipts will be issued for parts of the amount, and fractions of $1,000 will be paid in cash. The exchange mediums designated are: A. E. Appleyard & Company, Philadelphia and Boston; City National Bank, Columbus, Ohio; Springfield National Bank, Springfield, Ohio; Third National Bank, Dayton, Ohio; Central Trust and Safe Deposit Company, Cincinnati.

AUTOMOBILE NOTE.

AUTOMOBILE CLUB OF AMERICA TO CONDUCT A SPRING TOUR TO GETTYSBURG, ATLANTIC CITY AND LAKEWOOD—The governors of the Automobile Club of America have authorized the runs and tours committee to organize a spring tour to Gettysburg, Harrisburg, Reading, Philadelphia, Atlantic City, Lakewood and return, May 26 to June 2, inclusive, for members and guests. The start will be made from New York on Thursday morning, May 26, and the following itinerary is proposed: Thursday, May 26, New York to Philadelphia, 102 miles; Friday, May 27, Philadelphia to York, 91.5 miles; Saturday, May 28, York to Gettysburg, forty miles (luncheon at Gettysburg; afternoon to be spent in going over the battlefield); Sunday, May 29, morning and luncheon in Gettysburg, afternoon, run from Gettysburg to Harrisburg, thirty-five miles; Monday, May 30, Harrisburg to Philadelphia, 108 miles; Tuesday, May 31, Philadelphia to Atlantic City, 61.5 miles; Wednesday, June 1, Atlantic City to Lakewood, sixty-seven miles; Thursday, June 2, Lakewood to New York, eighty-three miles, making a total of 588 miles. Each day's run will be "go as you please," and members will rendezvous at the night stops at Philadelphia, York, Gettysburg, Atlantic City and Lakewood, where hotel accommodations and garage facilities are afforded. Mr. Emerson Brooks is chairman of the runs and tours committee.

TELEPHONE AND TELEGRAPH.

ONEIDA, N. Y.—A company has been formed to build a telephone line from De Ruyter to Lincklean.

ALEXANDER, N. Y.—The Darien Telephone Company has been granted a franchise to locate its system in Alden.

BRIDGEPORT, W. VA.—The Bell Telephone Company will shortly construct a farmers' line between Bridgeport and Cadiz.

HARDIN, ILL.—The directors of the Farmers' Telephone Company have perfected plans to extend the company's line from Hardin south to Meppin.

JOANNA, PA.—Work has been commenced on the extension of the Conestoga Telephone Company's line from Joanna to Hay Creek Valley, White Bear and Geigertown.

DULUTH, MINN.—The Mesaba Telephone Company is installing a special wire service between Hibbing and Duluth, and is also contemplating the installation of an exchange at Nashwauk.

NEW HAVEN, CT.—The Southern New England Telephone Company will erect a new four-story building in this city, at a cost of $22,000. This step is made necessary by the growth of the company's business.

SPARTA, MICH.—The Sparta Telephone Company's system has been sold to the Citizens' company. The new management will at once begin to overhaul the lines, put the exchange in first-class order and extend the rural lines.

FORT WAYNE, IND.—At the annual meeting of the South Bend Home Telephone Company, Theodore Thorward was elected president, M. B. Staley, treasurer, and Elmer Stoll, secretary. The annual report shows the company to be in a flourishing condition.

MORGANVILLE, KAN.—A telephone company has been organized here with a capital stock of $1,000. Officers were elected as follows: president, P. L. Swenson; vice-president, Henry Schneider; secretary, F. L. Fletcher; treasurer, L. V. Silver. Work is to begin at once.

WINONA, MINN.—The Winona Telephone Company will shortly commence work on the construction of five branch lines out of Rollingstone, and will also build a line through the towns of Wilson and Warren, largely increasing the number of farmer subscribers in Winona County.

HATTIESBURG, MISS.—The Cumberland Telephone Company has purchased the local system of the People's Telephone Company. This system comprises also long-distance lines to Laurel and connection with the long-distance system of the Mississippi Central Railroad Company.

CORTLAND, N. Y.—The directors of the Home Telephone Company have decided to install a new multiple switchboard at the central office, this step being made necessary by the great increase of business since the organization of the company. The company now has about 1,100 subscribers.

WATERBURY, CT.—The Southern New England Telephone Company purposes installing a complete system of underground subway for its main lines in this city, and has petitioned the authorities for permission to excavate certain streets, agreeing, in return, to install one duct for the perpetual use of the city.

PERSONAL MENTION.

MR. JOSEPH ROTHGARY, chief electrician of the Cleveland, Ohio, fire department for a number of years past, has resigned.

MR. JAMES M. JONES, who was for some time past assistant general manager of the Indianapolis Street Railway Company, has resigned.

MR. C. C. VANDEVENTER, of Kingman, Kan., was elected president of the Southwest Kansas Telephone Association, recently organized at Wichita, Kan.

MR. GARRISON BABCOCK, formerly with the Stromberg-Carlson Telephone Company, is now in the independent telephone construction business, with headquarters at 38 Rowley street, Rochester, N. Y.

MR. LEWIS F. LYNE has opened an office as consulting engineer at 10 Barclay street, New York city, N. Y., and is to make a specialty of power-plant matters. Mr. Lyne is also agent for several specialties.

MESSRS. ROSENBAUM & STOCKBRIDGE announce their copartnership, for the purpose of patent and trade-mark law and patent soliciting, and will be located at 149 Nassau street, New York city.

MR. S. TADA, of the Japanese Navy, and Messrs. Timita and Nishikawa, electrical engineers of Tokio, Japan, are reported to be in this country to purchase electrical apparatus for the Japanese Government.

MR. JAMES P. FELTON, who for the last ten years has been located at Schenectady, N. Y., with the General Electric Company, was recently appointed manager of the supply department at the Boston office of the company.

MR. J. T. P. KENYON, who has been connected with the engineering department of the New York Edison Company, has resigned from the company to become chief draughtsman of the electrical department of the New York Central & Hudson River Railroad.

MR. L. C. BRADLEY, who has for some time past been connected with the Seattle & Tacoma electric railroad, has been made superintendent of the Scioto Valley Traction Company, whose road will be in operation within a short time between Columbus and Lancaster, Ohio.

MR. W. B. POTTER, chief engineer of the electric railway department, Schenectady works, of the General Electric Company, has returned from a recent trip to the West Indies, whither he went to rest and recuperate, after a severe attack of the grippe and overwork.

MR. ALEXANDER McKENZIE, according to an announcement in the *New York Times* last week, has perfected a contrivance for a protected third rail, which will be presented to the Interborough Rapid Transit Company, in competition with other devices, for adoption.

MR. HENRY W. POPE, of New York, will have charge of the exhibit of the American Telephone and Telegraph Company at the World's Fair at St. Louis. Mr. Pope is an experienced and quite widely known telephone man, and these interests could not be in more capable hands.

MR. GEORGE B. HYDE, an American now residing at Silao, Mexico, is interested in a project to build three electric power plants in the state of Puebla, Mexico. Mr. Hyde has filed the necessary application with the Mexican authorities. The Zempoala river, in the district of Tetela, will be utilized.

MR. M. UGARTE, of the engineering and contracting firm of Ugarte & Garcia, Guadalajara, Mexico, is expected to arrive in the United States this week. This firm has large contracts for electrical machinery, and Mr. Ugarte will visit St. Louis, Pittsburg, Chicago and New York for the purpose of placing contracts.

MR. R. PAPE, the borough electrical engineer, Port Elizabeth, Cape Colony, South Africa, is engaged in drawing up plans for an electric lighting system at Port Elizabeth. The initial power-house equipment will consist of two 400-kilowatt generators, surface condensing plant and three boiler units. It is stated that some $400,000 is to be expended for machinery.

MR. ROBERT L. WARNER, who was manager of the Boston office of the Westinghouse Electric Manufacturing Company, has been appointed the New England manager of the company. Mr. Warner will have charge of the company's business in New England, and will be assisted by Mr. D. E. Manson, who has been appointed manager of the Boston office to succeed Mr. Warner in that capacity.

MR. LOUIS F. MAHLER, formerly manager of the De Laval Steam Turbine Company and the St. Louis manager of the Bullock Electric Manufacturing Company, is now representing the Buckeye Engine Company, of Salem, Ohio; the International Steam Engineering Company, of Atlanta, Ga., and New York, and Chase-Shawmut Company, of Newburyport, Mass., at suite 1008-1009 Chemical Building, St. Louis, Mo.

MR. BURR McINTOSH, in the *Burr McIntosh* monthly for May, reproduces a striking photograph of Mr. Nikola Tesla. In the editorial comment on the plates shown in this issue, Mr. McIntosh pays a fine compliment to Mr. Tesla on the work that he has done and is expected to do in scientific progress. The May issue is replete with beautiful reproductions of celebrities in both art and science, and

the publication is meeting with phenomenal success through its attractiveness to lovers of fine art.

MR. RICHARD H. PIERCE, formerly of Chicago, Ill., but at present located at Boston, Mass., has been appointed chief engineer to take charge of the power plant at the St. Louis World's Fair. Mr. Pierce was consulting engineer of the power plant at the Columbian Exposition at Chicago, and served later as consulting engineer for the Chicago City Railways Company. Mr. Pierce will be assisted in his work by Mr. Charles S. Foster, of Chicago, who was appointed by the exposition company a few weeks ago as chief operating engineer of the power plant.

MR. WILLIAM MARCONI is expected to arrive at Cape Breton, Nova Scotia, early in June, when he will begin transatlantic service by means of his wireless system. Before going to Table Head, where his main station is located, Mr. Marconi will confer with the government at Ottawa, regarding the use of a land line. New machinery has been installed at the Table Head station, and changes effected both inside and outside. There is also some disposition to make the Table Head station a repeating station between the stations at Wellfleet, Mass., and Poldhu, Cornwall, England.

COLONEL EZRA DE FOREST, the well-known general agent for New York of the Penn Mutual Life Insurance Company, of Philadelphia, is distributing the fifty-sixth annual statement of the company. The present year finds this old-established company making even greater expansions than in any other year in its history, and it is able to show an enviable record of success. At the beginning of the year the company had in force 114,831 policies, for $276,110,-015. During the year it issued 29,548 policies, for $69,728,754; and on December 31 it had in force 129,317 policies, for $308,786,092.

MR. EMERSON McMILLIN, who has large interests in the electric lighting and gas lighting companies of the United States, was one of the speakers at the annual banquet of the National Art Theatre Society last week, and stated, as one of a number, his willingness to donate $25,000 for the purpose of establishing and maintaining a proper theatre for this excellent organization. Mr. J. I. C. Clarke, the president of the society, and to whose indefatigable efforts its present success is due, thanked the liberal donor and expressed the belief that this meant the successful outcome of the plans of the organizers, which is the establishment of a theatre in New York city which will be an architectural ornament, to gradually form the best and most thoroughly trained company of English-speaking actors in the world, and to encourage American literature by giving production to adequate plays by American authors.

THE ENGAGEMENT has just been announced, at Baltimore, Md., of Miss Katherine Mortimer Montague to Mr. Charles Phillips Hill, of Pittsburg, Pa. Miss Montague is a granddaughter of the late Captain Arthur Sinclair, of the navy, a member of the Sinclair family of Scotland, of whom the Earl of Caithness is the head. Mr. Hill, who is of the Doubleday-Hill Electric Company, of Pittsburg, one of the largest American electrical supply houses, is of distinguished ancestry; he is a grand-nephew of the late W. W. Corcoran, the Washington philanthropist, a grandson of Judge Phillips, and his father, the late Colonel Hill, fought through the Civil War on the Confederate side. Mr. Hill has been identified, actively, with the electrical industry only about five years, but in that time his well-defined views of morality and integrity in commercial life have marked his successful career as especially noteworthy even in these days of sturdy young Americanism.

GENERAL EDWIN S. GREELEY, president of the Sons of the American Revolution, residing in New Haven, Ct., is the owner of the golden key which was used to officially open the St. Louis Exposition. The key is a telegraph transmitter of a special design, and is known as the Victor gold key. This was manufactured at General Greeley's electric supply house in New York city in 1892. It is nearly wholly made of gold, except the handles, which are of pearl, and some of the connections, which are of brass, gold-plated. The key was manufactured for the Chicago World's Fair, and was used by President Cleveland for this occasion. In 1896 President Cleveland used this in opening the electrical exhibit in New York city, and on the evening of the opening day the Hon. Chauncey M. Depew sent two messages of sixty-eight words each around the world. In 1898 President McKinley used this key in Washington, in opening the electrical exhibition in New York city. The key is mounted on a series of bases, suitably inscribed with the date of each event at which it has been used.

ELECTRICAL SECURITIES.

Apparently there is to be no immediate change in stock market actions. The past week was typical of the conditions that have now obtained for some time, and interest dribbled to almost total indifference toward the close of the week. No important gains or losses can be discovered in looking over the price changes for the week. The beginning of payments on the Panama canal, supplemented by other foreign requirements, brought about unusually large shipments of gold, but, notwithstanding, the bank statement showed an actual gain for the week, proving that the influx of coin from the interior was at this period more than offsetting an extremely large demand. The general agricultural situation, which has been unsatisfactory, is now improving with the advent of better climatic conditions. In the iron and steel trade there is also improvement, and while there is a quiet tone everywhere, the output of steel in general is not greatly below the largest ever known.

ELECTRICAL SECURITIES FOR THE WEEK ENDING APRIL 30.

New York:	*Closing.*
Brooklyn Rapid Transit	46¼
Consolidated Gas	209¼
General Electric	159¾
Kings County Electric	184
Manhattan Elevated	142½
Metropolitan Street Railway	112¼
New York & New Jersey Telephone	143
Westinghouse Manufacturing Company	175

The annual stockholders' meeting of the Interborough Rapid Transit Company will be held May 11, at 12 o'clock noon.

The directors of the Consolidated Gas Company have declared the regular quarterly dividend of 2 per cent, payable June 15. Books close May 26 and reopen June 16.

Boston:	*Closing.*
American Telephone and Telegraph	126¾
Edison Electric Illuminating	238
Massachusetts Electric	73
New England Telephone	121
Western Telephone and Telegraph preferred	75

The New England Telephone and Telegraph Company reports as follows for the year ended December 31, 1903: gross, $6,092,865; expenses and taxes, $4,677,726, leaving net of $1,415,139; dividends, $1,297,002, the surplus for the year amounting to $118,137, as compared with a surplus of $60,043 for the preceding year.

Philadelphia:	*Closing.*
Electric Company of America	7⅞
Electric Storage Battery common	57
Electric Storage Battery preferred	57
Philadelphia Electric	5⅜
Union Traction	49⅞
United Gas Improvement	84

Stockholders of the Electric Company of America held their annual meeting in Camden, N. J., April 26. The board of directors was reelected, and after the stockholders' meeting the board reelected the following: president, Colonel A. Loudon Snowden; first vice-president, John H. Catherwood; second vice-president, H. T. Hartman; secretary-treasurer, Frank B. Ball. President Snowden's report showed the net increase of the company for the year ending December 31 last to have been $434,679, an increase over that of 1902 of $44,008. After deducting expenses and dividends, the balance, which was credited to the profit and loss account, was $154,263. The total of that account is now $608,039, against $453,776 in 1902. There are now about 2,200 stockholders on the books of the company.

Chicago:	*Closing.*
Chicago Telephone	118
Chicago Edison Light	146
Metropolitan Elevated preferred	46¾
National Carbon common	29
National Carbon preferred	104
Union Traction common	5½
Union Traction preferred	30¾

NEW INCORPORATIONS.

CHASE, KAN.—The Chase Telephone Company. $10,000.

ENGLEVALE, KAN.—The Englevale Telephone Company. $5,000.

JERSEY CITY, N. J.—Pennington Telephone Company. $5,000.

NEWARK, N. Y.—The Newark Telephone Exchange. $25,000.

TOPEKA, KAN.—The De Soto & Olathe Telephone Company. $2,000.

ALEXANDRIA, NEB.—The Farmers' Telephone Company. $5,000.

INDIANAPOLIS, IND.—Harrison County Telephone Company. $10,000.

LAMARTINE, OHIO—The Diving Fork Telephone Company. $10,000.

TREMONT, ILL.—Tremont Independent Telephone Exchange. $20,000.

HARDIN, ILL.—The Calhoun Telephone Company. Increased from $15,000 to $25,000.

LA CROSSE, WIS.—Central Wisconsin Telephone Company. Increased from $5,000 to $50,000.

COLUMBUS, OHIO—The Steubenville & Wheeling Traction Company. Increased from $10,000 to $400,000.

FRANKFORT, KY.—The Princeton Electric Light and Power Company; $25,000. Home Telephone Company; $2,500.

IOLA, WIS.—The Iowa Telephone Company. $5,000. Incorporators: N. H. Johnson, F. W. Black and S. M. Myhre.

GUTHRIE, OKLA.—Union Light and Power Company. $350,000. Incorporators: Henry Smith, Robert Trulock and Ernest Blake.

MADISON, WIS.—Willow Springs Telephone Company. $4,000. Incorporators: John P. Sheldon, Frank McGarville and J. R. M. Phillips.

UTICA, WIS.—The Utica Telephone Company. $20,000. Incorporators: Jasper G. Pickett, Albon Parks, Robert W. Mackie and W. F. Munsil.

WASHINGTON, D. C.—Sitka Water and Light Company. $20,000. Incorporators: Edward S. Duvall, Jr., Warren Cochran and William T. Duvall.

LITTLE ROCK, ARK.—Ouachita Telephone Company. $25,000. President, M. A. Joy; vice-president, H. P. Snead; secretary and treasurer, W. P. Ritchie.

ROBERTS, WIS.—The Roberts Telephone Company. $5,000. Incorporators: A. Turner, Sr., David Imri, R. C. Andrus, George T. Turner and A. J. Walker.

GENEVA, IND.—Geneva Traction Company. $20,000. Directors: A. T. Briggs, E. F. Walsh, Charles D. Porter, J. H. Hordison, D. M. Shively, S. W. Hale and W. J. Horton.

SAN FRANCISCO, CAL.—The Century Electric Corporation. $250,000. Incorporators: F. M. Greenwood, C. M. Wood, E. F. Weihe, L. D. Hitzeroth and H. S. Tittle.

BETHEL, MINN.—Potato Belt Telephone Company. $20,000. Incorporators: Charles E. Burch, Minneapolis; Roland J. Dyer, Elmer E. Davis, George I. Sylvester, Samuel F. Cooper and Marcia A. Mitchell, Bethel.

ARLINGTON, MINN.—Farmers and Merchants' Telephone Company. $10,000. Incorporators: Adam C. Buck, Henderson; John Young, Frank F. Mansfield, Albert Zimmerman, Theodore Streissguth, Vincent F. Schmoll, Henry Hilleman, August C. Mallin, of Arlington.

ST. LOUIS, MO.—Southeast Missouri Ice, Light and Power Company, of Charleston; to operate an ice factory and electric light plant; $100,000; incorporators: J. Handy Moore, J. E. Armstrong and R. B. Boyce. Southeast Missouri Telephone Company, of Charleston; to establish and operate telephone exchanges at Charleston, Sikeston, Dexter, Malden, Campbell and Bloomfield; $150,000; incorporators: J. Handy Moore, Paul B. Moore, Mary Moore, J. E. Armstrong and R. B. Boyce.

ELECTRIC LIGHTING.

WHATCOM, WASH.—The city council has awarded a three-year contract to the local lighting company for city lighting.

MARION, IND.—The contract for the additional machinery to be installed in the city electric plant has been let to the Westinghouse company.

WHEELING, W. VA.—The Belmont Electric Light and Power Company is planning additions and improvements to its plant that will almost double its capacity.

APPLETON, WIS.—The Green Bay & Mississippi Canal Company recently purchased at foreclosure the entire interests of the Kaukauna Water Power Company, the price being $118,000.

MONTROSE, COL.—The Montrose Electric Light and Power Company has completed a deal for a new site for the large electric power, cold storage and ice plant which it will erect this summer.

SYRACUSE, N. Y.—The St. Lawrence International Electrical Lighting Company has made a new street lighting contract with the village of Alexandria Bay for an increased number of lights, at a higher price.

BALTIMORE, MD.—The Maryland Telephone and Telegraph Company has secured the passage in both branches of the city council of an ordinance permitting it to engage in the lighting business in the city of Baltimore.

JERSEY CITY, N. J.—Jersey City's street and water board has granted permission to the United Electric Company of New Jersey, now part of the Public Service Corporation, to construct subways for electric light, heat and power wires on certain of the city streets.

HATTIESBURG, MISS.—The Hattiesburg Light and Power Company has closed a contract for $10,000 worth of new machinery. The plant will be in full operation with the new machinery installed within the next ninety days, and about 150 new street lights will probably be put in.

CLARKSVILLE, ARK.—At a meeting of the city council E. T. McConnell was granted a franchise for an electric lighting plant. The franchise is to extend over a period of thirty years, and work is to be commenced within sixty days from the date on which it was granted and be completed within six months.

RICHMOND, VA.—Ground has been broken for the new heat, light and power plant at the state penitentiary, and work will be commenced at once on the structure, which is to cost $50,000. It is proposed that the plant shall furnish heat, light and power for the building, and it is hoped to have it in operation by the fall.

PHILADELPHIA, PA.—The borough of West Conshohocken has entered into a contract with the Conshohocken Electric Light Company to light the streets at $15 an incandescent light, on condition that the borough exempt the company from pole tax and expect no reduction for the time lamps are out, unless the company is directly responsible.

MARTINSVILLE, VA.—Martinsville is contemplating the installation of a municipal electric lighting plant. An option has been secured on the water power of Smith river, at a point one and one-half miles south of the town, where it is thought 1,200 horse-power can be developed. It is believed that the total cost of the plant will not exceed $70,000.

EASTON, PA.—At the annual meeting of the People's Electric Light and Power Company the following directors were elected: E. W. Evans, John S. Osterstock, Frank G. Ormsby, S. R. Bush and Matthew H. Jones, Easton; G. B. Garrison, New York city, and W. H. Walter, Phillipsburg. The board reelected E. W. Evans, president; John S. Osterstock, treasurer, and Frank G. Ormsby, secretary.

ALLEGAN, MICH.—Sale has been made of the Allegan Light and Power Company's plants to Siebe Baker, Hiram A. De Lano, George E. De Lano, of Otsego, and Fenner M. Van Auken, of Allegan. The consideration is not definitely known, but it is understood to be $15,000. The new owners will continue the business under the same name, supplying light and power for commercial and domestic purposes. There are two plants, which will probably be consolidated.

ELECTRIC RAILWAYS.

HUNTSVILLE, ALA.—The Eastern Railway Company is making plans to extend its line to the village of Merrimack.

DECATUR, ILL.—The city council has granted to the McKinley syndicate a thirty-five-year franchise to operate an interurban line.

FAIRMONT, W. VA.—The Fairmont & Mannington Electric Railroad Company has been chartered to build an electric road from Fairmont to Mannington.

WEST LIBERTY, IOWA—A franchise has been granted to the Iowa City & Davenport electric line, permitting it the use of several streets within the city limits.

JAMESTOWN, N. Y.—The Chautauqua Traction Company announces that its new route from Jamestown and Lakewood to Chautauqua and Bemus Point will be open for traffic on June 1.

PHILADELPHIA, PA.—The contract for building the new trolley line from Lakewood to Point Pleasant has been let. This is part of the system destined to connect Trenton with towns along the Atlantic coast.

CONNELLSVILLE, PA.—All the rights of way have been secured for the proposed trolley line from West Newton to Jeannette, and work will begin at once. The route takes in Adamsburg, Arona, Herminie and other small towns.

CARBONDALE, ILL.—The necessary steps have been taken by business men of this city to incorporate a company for the purpose of building an electric railroad from this city to Carterville, to connect with the Williamson County coal belt road.

WINDER, GA.—The electric car line which is now being planned from Anderson, S. C., *via* Hartwell, Commerce, Jefferson, Winder and Logansville to Atlanta is in charge of the Georgia Traction Company. The line will be used both for passenger and freight transportation.

PLAINFIELD, N. J.—The Public Service Corporation proposes to build a trolley line between this city and Metuchen, which will connect at the latter place with a line to Perth Amboy. It will be known as the seashore route, the expressed intention being to make the line run to the ocean.

BANGOR, ME.—The contract for the construction of the Rockland, South Thomaston & Owl's Head Electric Railway has been awarded. The first section to be built will be that from Rockland to Crescent Beach, and this will be ready for business at the opening of the summer season.

COALGATE, IND. TER.—The Lehigh Traction Company, a corporation chartered to construct an electric railroad from Atoka to Coalgate, passing through the towns of Midway, Lehigh and Phillips, has let the contract for building the road from Coalgate to Lehigh, a distance of eight miles.

LEXINGTON, KY.—The Blue Grass Traction Company, operating the electric railroads from this city to Paris and Georgetown, has placed a mortgage on all its tangible assets for $700,000, in favor of the Cleveland Trust Company, of Cleveland, Ohio. It is said that the money is to be used in the construction of other lines.

INDIANAPOLIS, IND.—At the annual meeting of the Muncie, Hartford & Fort Wayne Railway the stockholders reelected the board of directors, and the following officers were then chosen: president, S. M. Hexter; vice-president, A. L. Johnson; treasurer, J. C. Gilchrist; secretary, F. M. Osborn; assistant secretary, A. Lewenthal.

PITTSBURG, PA.—The promoters of the Pittsburg & Allegheny Valley Street Railway Company state that work on the road between Leechburg and Apollo will begin shortly. The road will have connections at Leechburg with the extensions of the Kittanning & Ford City electric line, and will ultimately enter Pittsburg over the tracks of the Pittsburg Railways Company.

ELKHART LAKE, WIS.—A trust deed given by the Sheboygan, Elkhart, Lake Street Railway and Power Company to the First Trust and Savings Bank, of Chicago, covers an issue of bonds not to exceed $800,000, to complete the line from Elkhart Lake and Sheboygan by way of Waldo and Plymouth. The work will begin as soon as possible, and the line is expected to be in operation July 15.

ROCHESTER, N. Y.—The work of construction on the Rochester, Syracuse & Eastern Railroad, which, when completed, will be the longest double-track electric railroad in the United States, will be begun shortly. The road will begin at the city line of Rochester, where the tracks of the Rochester Railway Company end, and will continue over private right of way eastward to Syracuse, about eighty-five miles.

CLEVELAND, OHIO—It is announced that Samuel S. Burtsfield, of Toledo, is interested with B. B. Avery, of Cleveland, and Sherman Culp, of Norwalk, in the organization of a company to build an electric road south from Norwalk, Ohio, to Fairfield, thence west through Greenfield to Chicago Junction, to New Haven and Plymouth, where it will connect with the Mansfield and Shelby line, which is to build north to Plymouth.

WALLINGFORD, CT.—The Wallingford Tramway Company will at once begin the construction of a street railroad from this borough to Montowese, in the town of North Haven, where connections will be made for New Haven with the Fair Haven & Westville Railroad Company. The road will be seven miles long and the materials for it have been ordered. At Wallingford it will connect with the tracks of the Meriden Electric Railway Company. The road will be a connecting trolley link between New Haven and Hartford.

INDIANA, PA.—The franchise of the Indiana Street Railway Company has been purchased by John P. Elkin, and the company will be merged with the Indiana & Blairsville Intersection Railway Company, in which he is interested. The lines, as proposed, will pass through all the principal towns along the Indiana branch from this place to Blairsville. On the north they will reach Ernest, Creekside and Italy, and cover the territory traversed by the Indiana branch of the Buffalo, Rochester & Pittsburg Railroad Company.

JEFFERSON CITY, MO.—The Lexington & Suburban Railway Company, of Lexington, has been chartered. The company has a capital of $250,000, owned chiefly by Mr. Gustav Hearle, of Lexington, the other stockholders being Ira G. Hedrick, A. G. Sutherland, L. R. Ash and V. H. Cochrane, of Kansas City. The road is to be twenty-five miles in length and run from Mayview, on the Chicago & Alton line, north through Lexington to Henry, in Ray County, on the line of the Wabash. The line is to be electric and to cross the Missouri river at Lexington.

AUGUSTA, ME.—The railroad commissioners have approved the petition of the directors of the Dover, Foxcroft & Sebec Lake Railway Company, of Foxcroft. This company has been organized for the purpose of building and operating an electric railroad between Foxcroft, Piscataquis County, and some point on the southerly shore of Sebec lake, a distance of five miles. The capital stock is $30,000. The directors of the company are B. L. Dickinson and George W. Taylor, Lexington, Mass.; H. L. Jones, Boston; A. H. Stanhope, Dover; W. E. Parsons, A. W. Gilman, Willis S. Ham, Foxcroft.

FORT COLLINS, COL.—The county commissioners have voted a franchise to P. H. McHugh for the construction of an electric railway through Larimer County. The franchise stipulates that the building of the line must be begun by January 1, 1906. It is stated that well-known eastern capitalists are behind the scheme, and that the road is a certainty. W. O. Mosman has also secured a franchise from Larimer County, giving him a right of way for an electric railway from a point twenty miles northwest of Fort Collins to North Park. This road, when built, will connect with the line to be constructed by P. H. McHugh.

TRENTON, N. J.—The Vandegrift Construction Company, of Philadelphia, has announced its intention of building a new trolley system to the shore by way of Trenton and New Brunswick railroad to Milltown Junction, from there to South Amboy over the Middlesex and Somerset division of the Public Service Corporation, and from South Amboy to Red Bank over the Jersey Central Traction Company's lines. At Red Bank connection will be made with the Monmouth Traction Company for Long Branch, and at Long Branch the cars will connect with the Atlantic Coast Electric Railway for Asbury Park, Ocean Grove and Belmar.

LANCASTER, PA.—The Brandywine Electric Street Railway Company has transferred all its interests in Chester and Lancaster counties to the Philadelphia, Coatesville & Lancaster Electric Company, the consideration being $1. The latter company has given a mortgage to the Integrity Title Insurance, Trust and Safe Deposit Company to secure an issue of $600,000 of bonds. The proceeds of these bonds will be applied to the building of the line, which will extend from Coatesville to Parkersburg, Atglen, Christiana and Gap, through eastern Lancaster County, to a connection with the Lancaster system. With the completion of this line trolley service from Marrietta to Philadelphia will be assured.

INDUSTRIAL ITEMS.

THE MAGNET WIRE COMPANY, New York city, N. Y., recently moved its offices to 40 Broadway. The company reports a good business.

THE CRESCENT COMPANY, Chicago, Ill., announces that it has secured the western sales agency of the P. R. Wagor Manufacturing Company, and it is prepared to quote prices on its entire line of lamp guards.

THE INCANDESCENT LIGHT MANIPULATOR COMPANY, 116 Bedford street, Boston, Mass., has issued a leaflet illustrating and describing the electric lamp guards which it manufactures. Leaflet will be sent on request.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has issued its May, 1904, calendar of great men of science and engineering. This calendar contains a photograph of Mr. Charles Proteus Steinmetz, and on the back of the calendar is the usual biography.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., will be pleased to quote to its customers and other prospective buyers prices on next winter's supply of lamps. The company announces that it is in position to take good care of all contracts, and will fill these with high-grade Packard lamps.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, invites its patrons to examine its exhibit in Machinery Hall, location 5-G, block 26, when visiting the St. Louis Exposition. The company has prepared a most comprehensive display of a large line of high-grade engineering specialties, which it manufactures.

STANLEY & PATTERSON, INCORPORATED, announces the removal of its general offices and salesrooms from 93 Liberty street to larger and more commodious quarters at 40 Cortlandt street, New York city. The company's uptown store is at 329 Fourth avenue. Both of these stores are connected to the private branch exchange switchboard, No. 5900 Cortlandt.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is sending out its catalogue treating on "Dixon's" graphite pipe joint compound. The catalogue states that the compound is not a cement; it is a lubricant, and a material that makes tight joints for steam, water, air, oil, brine and gas piping, and resists heat, cold, acids and alkalies, and protects the threads from corrosion. Catalogue will be sent on request.

THE PHELPS COMPANY, Detroit, Mich., manufacturer of the celebrated "Hylo" turndown lamps, has published a booklet entitled "How to Read Your Meter." This gives some very pointed information with regard to the function and operation of a wattmeter, and is directed particularly to the average consumer. Supplementing the instruction is considerable matter concerning the economy of the "Hylo" turndown lamp.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., in bulletins Nos. 1,053 and 1,054, issued for February and April, respectively, describes single-phase integrating type K wattmeters and small rotary transformers, self-exciting alternators and motor-generator sets. Another recent publication is instruction book No. 3,019. This describes single-phase "Wood" alternating-current generators and their connections.

THE WHITE SEWING MACHINE COMPANY, Cleveland, Ohio, manufacturer of the White automobile, has issued the "White Bulletin" No. 5. On the frontispiece is a handsome reproduction of the Huntington challenge cup, presented by deed of gift to the Automobile Club of Southern California. This was won by H. D. Ryus with the White steam car, driving over a distance of five miles. There is the usual complement of pithy editorials, and these are supplemented by a number of half-tone illustrations of typical automobile scenes.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., manufacturer of electric generators and motors, will, on May 10, open a branch office in the Hibernia Bank Building, New Orleans, La. Mr. W. P. Field, of the St. Louis office of the company, will be the representative in charge. Although there are fifteen Crocker-Wheeler branches from Boston to San Francisco, including St. Louis and Atlanta, the establishment of this new office has become necessary, in order to accommodate the steadily increasing market for electric machinery in the South and Southwest.

THE CHARLES E. DUSTIN COMPANY, 11 Broadway, New York city, is furnishing the Valley Traction Company, Chambersburg, Pa., with three large direct-connected units for its new power-house at Bridgeport, Pa. Two of the units are 250-kilowatt Westinghouse 2,200-volt two-phase sixty-cycle four-pole alternators, direct-connected to 16 and 30 by 24 Pennsylvania Iron Works cross-compound engines. The other is a 300-kilowatt Westinghouse eight-pole 550-600-volt direct-current generator, direct-connected to a 20 and 32 by 24 Pennsylvania Iron Works cross-compound engine.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York, is supplying the Dreamland Company, Incorporated, Coney Island, N. Y., with several thousand squares of "Asbestoside," to be used for siding the buildings in "Dreamland," which will be one of the largest pleasure resorts on Coney Island. The distinctive features of "Asbestoside" are, that it is cut into sheets of seven feet and crated; is easily applied, being finished with large head galvanized nails which are covered with a half round wooden beading or moulding. "Asbestoside" will not rust or decay.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued from its power and mining department a very complete catalogue descriptive of electric mine locomotives. The reading matter describes the salient features of the General Electric Company's mine locomotives, and reprints an interesting article from "Mines and Minerals," on "Electricity *versus* Air." In addition to this there are chapters on gathering coal with electric mine locomotives, a description of the electric plant of the Webster Coal and Coke Company, at Ehrenfield, Pa., and other interesting data on the use of electricity in mines. The letter-press is supplemented by handsome half-tone engravings, showing typical applications of the electric locomotive.

THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY will run a special train to Boston for the convention of the National Electric Light Association, to be held May 24, 25, 26 and 27. This train will be run for the exclusive use of the convention attendants. The train will be made up of special sleeping cars, with dining and buffet library cars. It will run as the first section of the New England Express, leaving Chicago at 2 P. M., Sunday, May 22; Toledo, 7.50 P. M.; Cleveland, 10.30 P. M., arriving at Boston at 5 P. M. Monday. A rate of a fare and one-third for the round trip, on the certificate plan, has been authorized, which will be available leaving Chicago as early as May 20, and good, returning, leaving Boston not later than May 31.

THE NERNST LAMP COMPANY announces that it has established a branch office, auxiliary to the Pittsburg district office, at 537 Scofield Building, Cleveland, Ohio, in charge of Mr. J. C. Wright. The company will carry at this office a stock of Nernst lamps and renewal parts, ensuring prompt attention to all orders in this district. The company is also becoming widely introduced in the New England district. It has recently received two large orders, one from the Saco & Pettee machine shops, Biddeford, Me., for 575 three-glower lamps, and one from the Arlington mills, Lawrence, Mass., for 600 lamps of the forty-four-watt type. The second order comes in as a testimonial, as quite a large installation of Nernst lamps had been sold to the latter company previously.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., announces that it has at the St. Louis Fair an extensive and comprehensive exhibit located in block 20, of the Electricity Building. A conspicuous feature of the company's exhibit is a map about thirty feet in height by forty-five feet long, which by an ingenious arrangement shows the distribution of chloride accumulator installations throughout the United States. Illuminated glass jewels designate the location and character of the various installations, whether for railway, central station, isolated lighting and power service, yacht plants, telephone installations, etc. There is also set up in a model battery-house a complete operating installation of chloride accumulators for railway service. Specimens of chloride accumulators, ranging in size from a 61-H type of cell to the smallest laboratory types, are shown, together with a complete exhibit of Exide batteries for use in electric automobiles. In another section of the exhibit there are five types of switchboards, together with end-cell switches, storage battery recording instruments, etc.